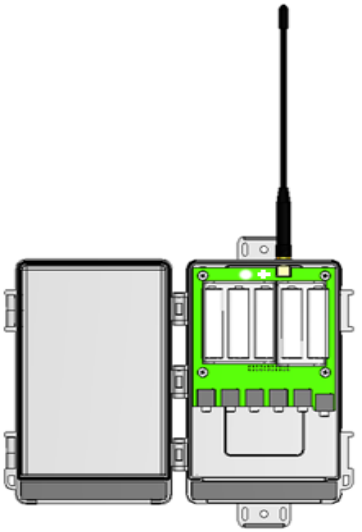
# Em50/Em50R/Em50G

## Em50 Series Data Collection System

User's Manual



Version 7

DECAGON DEVICES

UMS measure to know

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# 1. Introduction

Thank you for choosing the Em50 data logger series. These data loggers are designed and suited for field research and commercial agriculture. This manual will explain the Em50's capabilities and functions.

**NOTE***: Except where specified, all functions and specifications relating to the Em50 also relate to the Em50R and the Em50G.*

## Customer Support

If you ever need assistance with your Em50, or if you just have questions or feedback, there are several ways to contact us:

**Phone:**
**1-800-755-2751** (Toll free to customers in US and Canada)
**1-509-332-2756** (for international customers)

Customer service representatives are available to speak with you Monday thru Friday, between 8am and 5pm Pacific time.

**Fax:**
**1-509-332-5158**

**E-mail:**
**support@decagon.com** or **sales@decagon.com**

If contacting us by email or fax, please include as part of your message your instrument's serial number, your name, address, phone, and fax number.

You can also send feedback to Decagon using $ECH_2O$ Utility's "Send Feedback to Decagon" feature. See Appendix B for more information.

**NOTE***: If you purchased your Em50 through a distributor, please contact them for assistance.*

## Software Downloads and Updates

Go to www.Decagon.com/support/downloads if you need to download firmware updates, software updates and/or drivers .

## Warranty

All Decagon products have a 30-day satisfaction guarantee and the Em50 has a one-year warranty.

## Seller's Liability

Seller warrants new equipment of its own manufacture against defective workmanship and materials for a period of one year from date of receipt of equipment (the results of ordinary wear and tear, neglect, misuse, accident and excessive deterioration due to corrosion from any cause are not to be considered a defect); but Seller's liability for defective parts shall in no event exceed the furnishing of replacement parts F.O.B. the factory where originally manufactured. Material and equipment covered hereby which is not manufactured by Seller shall be covered only by the warranty of its manufacturer. Seller shall not be liable to Buyer for loss, damage or injuries to persons (including death), or to property or things of whatsoever kind (including, but not without limitation, loss of anticipated

profits), occasioned by or arising out of the installation, operation, use, misuse, nonuse, repair, or replacement of said material and equipment, or out of the use of any method or process for which the same may be employed. The use of this equipment constitutes Buyer's acceptance of the terms set forth in this warranty. There are no understandings, representations, or warranties of any kind, express, implied, statutory or otherwise (including, but without limitation, the implied warranties of merchantability and fitness for a particular purpose), not expressly set forth herein.

## Specifications

**Input Ports:** 5, 12-bit analog or 32-bit digital
**Port type:** 3.5mm "stereo jack" connector
**Data Storage:** 1MB (36,800 scans for all 5 ports)
**Memory type:** Non-Volatile Flash
**Battery capacity:**5 AA Alkaline or Lithium batteries
**Enclosure:** Weatherproof, impact and UV-resistant polymer
**Enclosure rating:** IP55, NEMA3R
**Operating environment:** 60° to -40°C, up to 100% RH
**Communication:** Dedicated serial port 3.5mm stereo jack for use with the Decagon USB Cable Adapter (UCA).
**Radio (Em50R models):**
902 - 928 MHz ISM *North America*
915 - 928 MHz ISM *Australia, New Zealand, Israel*
2.4 GHz ISM *Worldwide*
**Cellular (Em50G):** *GSM/GPRS Cellular technology. Cellular service and data hosting service provided by Decagon Devices.*

# 2. Em50/Em50R/Em50G

## Em50 Logger Series Overview

Introduction

The $ECH_2O$ System is made of data loggers, sensors, telemetry, and software that help you measure soil moisture and other environmental parameters accurately and cost effectively. Decagon's innovative sensors are the heart of the system. Decagon also designed the system to be very easy to use (no programming needed).

**About the Em50 Logger Series.** The Em50 is a 5-port, self-contained data logger especially suited for field research and commercial agriculture. The Em50 logger series includes three models: the Em50, the Em50R and the Em50G. These devices are housed in a weather-resistant enclosure, making them suitable for long-term outdoor operation.

Em50

The Em50 is the basic logger. The communication with this model is through a stereo to USB or stereo to Serial cable to a PC or mobile handheld device.

Em50R

The Em50R includes a spread-spectrum radio telemetry module. The radio module is available in long-range 900 MHz and 2.4 GHz frequencies. Use the telemetry in energy efficient transmit mode or two-way mode. (See Chapter 6 for more information on telemetry.)

Em50G

The Em50G includes GSM/GPRS (Global System for Mobile communications/General Packet Radio Service) cellular module to allow environmental measurement data available over the internet. Decagon partners with a provider of global cellular data service to make data transmission and maintenance easy and inexpensive. Measurements from the Em50G are sent wirelessly to Decagon's internet server and are available for download using DataTrac software (through the use of Em50G Downloader application).

Em50 Compatible Sensors

You can use the Em50 to log data for almost all of the sensors that Decagon sells (excluding the UMS and thermal sensors). Please see our website (www.decagon.com) or our catalog for an up-to-date list of supported sensors.

## Software

The Em50 series gives you two software options for working with your hardware and collected data. Choose one or both packages to fit your needs. Download the latest versions of these programs at **www.decagon.com/support/downloads.**

$ECH_2O$ Utility

$ECH_2O$ Utility is free software that is included with your purchase. It provides a simple way to connect to and configure your loggers. The $ECH_2O$ Utility makes downloading and processing your measured data fast and easy.

- Connect to Em50 loggers directly or with radio telemetry.
- Set all logger configuration parameters with visual controls.

- Make real-time sensor measurements (scan sensors).
- Create Excel or text files with raw or processed data.
- Create configuration and data files for use with DataTrac.

DataTrac

DataTrac is the premier $ECH_2O$ System software designed to help you organize and visualize your measurement data. DataTrac is particularly useful if you have several data measurement sites and don't want the hassle of managing the data after each download. It is the only $ECH_2O$ software that lets you easily apply custom calibration to sensor data. DataTrac comes with the Em50 system as a 30-day trial version. If you would like to continue to use DataTrac, contact Decagon to purchase a DataTrac license. Along with most of the features of $ECH_2O$ Utility, DataTrac also offers:

- Powerful charting engine shows data graphically.
- Simple table view allows data manipulation.
- View summarized data based on chart period.
- Automatically organize and store data for each Em50 logger in a device directory tree.
- Apply sensor-specific calibration to data.
- Create reports with chart and summary data. Print or save as PDF.
- Easily transfer data and configuration to other DataTrac users.

$ECH_2O$ Utility Mobile

$ECH_2O$ Utility Mobile is designed to bring the usefulness of $ECH_2O$ Utility to Windows powered mobile devices or hand-

held computers (PDA). Use this software and your PDA in the field instead of your expensive laptop. This software will configure your logger, download data, and make real-time sensor measurements. Like the desktop version, $ECH_2O$ Utility Mobile allows you to:

- Connect directly or with radio telemetry to Em50 loggers.
- Set all logger configuration parameters with visual controls.
- Make real-time sensor measurements (scan sensors).
- Creates configuration and data files for use with DataTrac.
- Creates data files for use with $ECH_2O$ Utility.

$ECH_2O$ Utility Mobile works with most Windows PDAs, including the HP iPAQ. Decagon Recommends using the Juniper Systems Archer field PC (available from Decagon). This ultra-rugged mobile device is designed to work in field conditions where typical PDA hardware will fail. Please see the $ECH_2O$ Utility Mobile manual for more information on system requirements to use your PDA with the $ECH_2O$ System.

Em50G Downloader

The Em50G Downloader software is a Windows application that works with DataTrac to download measurement data from Decagon Data Service. The Em50G Downloader is only necessary to subscribe to data collected by Em50G loggers and is not used with the other models of the Em50 logger. See Chapter 5. Em50G Cellular Communication for more information about the Em50G Downloader.

## Em50 Series Data Logging Scheme

The Em50 will not make sensor measurements until you set a measurement interval. You also need to configure the Em50 ports with the type of sensor plugged into each port. You can set these values using the software described in the previous section.

Em50 Measurement Interval

The measurement interval controls how often data is recorded in the Em50's internal data storage. The interval you choose applies to all 5 ports on the Em50, therefore, it is not possible to have one port measuring sensors more or less frequently than another port.

The measurement interval works relative to the Em50's internal real-time, 24-hour clock. For example, when choosing a measurement interval of 120 minutes, the Em50 will store data every two hours, on the hour. The resulting data will show sensor measurements hourly at 12:00 a.m., 2:00 a.m.,..., 10:00 p.m. Choosing a measurement interval greater than 720 results in one set of data stored per day. For most applications, a measurement interval of 60 or 120 minutes is appropriate.

**NOTE:** *Setting the Em50 measurement interval to zero turns off sensor measurement and data storage.*

For most sensor types, the Em50 makes a measurement from each of the 5 sensor ports every 60 seconds, regardless of the measurement interval value. When the Em50's internal clock reaches the user-programmed measurement interval, the Em50 stores the average of all the 60-second sensor readings taken since the last storage interval. Therefore, if you set the measurement interval to 60, the Em50 will actually store an average of the past 60 sensor readings. If you choose an interval of

1440, the Em50 will store one value that represents the average sensor value for the entire 24-hour period.

**NOTE:** *The Em50G supports 5 minutes as the minimum value for the measurement interval setting.*

Data Storage Format

The Em50 stores "raw" data for each sensor. The stored values are not in millivolt units. See Chapter 9: Compatible Sensors, for equations to convert raw data to meaningful sensor values.

How the Em50 Stores Data

The Em50 stores data for all five sensor ports for each measurement interval. If no sensor is connected to one or more of the logger's ports, the Em50 will store a "0" for that port. The Em50's data memory is non-volatile flash. Removing the batteries or performing a system reset will not erase your data. However, it will reset the clock in the data logger. To reset the clock to the correct time, simply connect your Em50 to a computer or handheld device running $ECH_2O$ software.

Data Storage Size

The Em50 stores more than 36,800 data scans. When the logger has filled its data memory, it begins overwriting the oldest data in the memory.

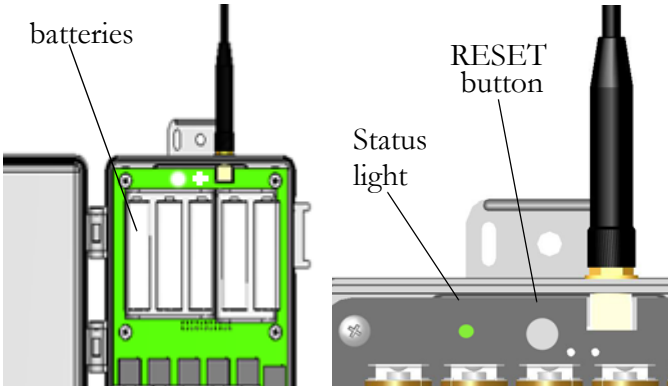
Measurement Span

Depending on the set measurement interval, the Em50 can read for several weeks to several years before its memory has filled. When you set up your Em50 using $ECH_2O$ Utility, the software will display how many days of data the Em50 will hold based on the measurement interval that you have chosen. You can determine how many days of data your Em50 will hold by dividing the size of the data memory (36,864 scans) by the

measurement interval. For example, an Em50 set on an hourly measurement interval will store 1,500 days, or about 4 years, worth of data. An Em50 set to five minutes will store data for 125 days, or about four months.

# 3. Setup and Installation

## Installing the Batteries




The Em50s are shipped with a new set of AA alkaline batteries. Open the case and install the batteries in the proper orientation as indicated in the battery locations. After installing the batteries, press the silver Reset button located directly above the batteries.

**NOTE**: *Installing or changing the batteries in your Em50 resets the internal real-time clock. You must connect to your Em50 using any ECH$_2$O System software to reset the logger's clock. If you don't set the logger's clock, the time and date associated with each measurement will be incorrect.*

The Em50 is powered by 5 AA-size Alkaline batteries. With the radio or cellular modules disabled, a set of Alkaline or Lithium batteries can last for several years. The battery life for Em50Gs and Em50Rs varies depending on how the transmis-

sion is setup. (See Chapter 6.) Battery power in the Em50R and Em50G can last from six months to over a year.

You can check the battery level status when the Em50 is connected using any $ECH_2O$ software. When the battery life indicator shows that your Em50's batteries are less than 5%, you should replace them.

Reset Button

All Em50 logger types have a "RESET" button. If your logger doesn't respond to connection attempts or doesn't appear to be working, press the reset button. This will reboot the logger and the "STATUS" light will turn on momentarily. The internal data storage of the logger is non-volatile so you will not loose data or settings if you press the reset button.

Em50/Em50R STATUS Light

The green "STATUS" light indicates the current status of your Em50 or Em50R logger.

- A short, single blink every 5 seconds indicates the Em50 is configured to log sensor data. The light doesn't blink if the logger's measurement interval is set to 0 or "Off".
- A slow on/off blink indicates the Em50 is connected to an active serial port.
- A rapid continuous blink indicates the logger's date and time are not set correctly. This can happen when the batteries have been disconnected. You must connect to your Em50 using any $ECH_2O$ System software to reset the logger's internal clock. The logger will stop error blinking when the date is reset or after 2 minutes have elapsed (to preserve battery power).

Em50G Status Lights

The "OK" (green) and "ERROR" (red) lights indicate the current status of your Em50G logger.

- The lights indicate the status of the logger's self test function (see below).
- A short, single blink of the "OK" (green) light every 5 seconds indicates the Em50G is configured to log sensor data. The light doesn't blink if the logger's measurement interval is set to 0 or "Off".
- The "OK" (green) light blinks slowly on/off blink indicates the Em50 is connected to an active serial port or the cellular module is powered on.
- The "OK" (green) light pulses when the Em50G is actively sending data over the cellular network.
- The "ERROR" (red) light blinks continuously to indicate the logger's date and time are not set correctly. This can happen when the batteries have been disconnected. You must connect to your Em50G using any ECH$_2$O System software to reset the logger's internal clock. The logger will stop error blinking when the date is reset or after 2 minutes have elapsed (to preserve battery power). Pressing the "TEST" button may also reset the loggers clock by using the time of the cellular network if the connected network supports time information.

Em50G TEST Button

The Em50G logger has a TEST button to perform basic functionality testing. When you press the TEST button, the logger performs several checks on internal systems and attempts a communication session over the cellular network. The logger uses the status lights during the test as follows:

- Both the "OK" (green) and "ERROR" (red) lights blink slowly while the Em50G is performing the tests. Please be patient. It can take as much as 60 seconds or more to finish the cellular communication tests.
- The "OK" (green) light pulses when the Em50G is actively sending data over the cellular network.
- A solid "OK" (green) light indicates the internal tests passed and there was successful communication over the cellular network to the Decagon Data Service. The Em50G leaves the light on for approximately 20 seconds.
- A solid "ERROR" (red) light indicates an error in the logger or in communicating to the Decagon Data Service. Please use the Communication Test feature in $ECH_2O$ Utility to find the specific error.

## Installing Software

The included $ECH_2O$ Utility and DataTrac software allow you to collect and manage data from your device. The Em50G Downloader software is included if you have an Em50G.

**NOTE:** *This manual documents $ECH_2O$ Utility. Most tasks that can be performed using the $ECH_2O$ Utility can also be accomplished using DataTrac or $ECH_2O$ Utility Mobile. For more information about using DataTrac or $ECH_2O$ Utility Mobile, please refer to their respective manuals.*

To install $ECH_2O$ Utility, DataTrac, or Em50G software, place the CD in your CD drive, and wait for it to auto-launch. If it doesn't launch, go to My Computer, select your CD drive, and click on the "setup.exe" file. A driver for the accompanying USB cable can also be installed at this time.

Occasionally, new versions of $ECH_2O$ System software will become available on Decagon's website. They can be accessed at **www.decagon.com/support/downloads.**

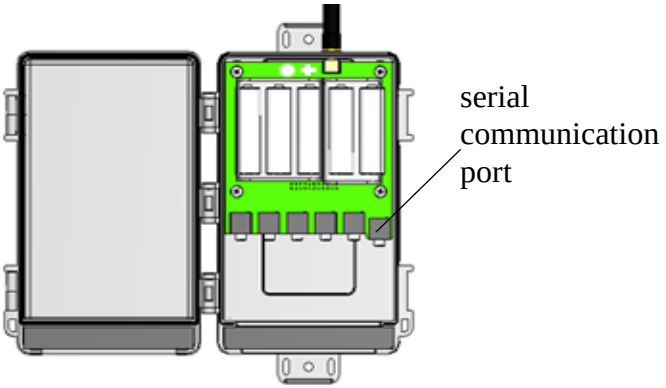
You can find your current software version in the "About" option of the Help menu in the $ECH_2O$ Utility and DataTrac. If you are connected to the internet, select "Check for Updates" in the Help menu to see if there is a newer version available.

Decagon USB Cable Adapter (UCA) Driver Installation
You must install a driver for the USB Cable Adapter (UCA) before you can use it to communicate with your logger. You can find the driver installer on your $ECH_2O$ System Software CD or from Decagon's website at www.decagon.com/support/downloads.

## Configuring in $ECH_2O$ Utility

Before field installation, the Em50 needs to have certain parameters set, such as name, date and time, measurement interval, and communication mode. Also, the radio-enabled Em50R and the cellular Em50G will not respond to wireless contact until properly configured to do so. To configure the logger, do the following:

1. Open the $ECH_2O$ Utility program.
2. Plug the 3.5 mm connector of the UBS cable (included with your Em50) into the logger's COM port, and plug the USB into the serial port of your computer.




*Port diagram*

3. At the top of the screen, select the appropriate COM port from the "Connect Via" drop-down menu, then click on the "Connect" icon. If you are using the USB Cable Adapter, look for the "Connect Via" option that includes "Decagon UCA" in the COM port name.

**NOTE:** *If you cannot connect to your Em50, you may need to install the driver for the USB cable. To download a driver go to www.decagon.com/support/downloads.*

4. Once you have successfully connected, the menus on the main screen will become active.

5. At the device setup screen that appears, click on the various fields to enter a name for your logger and choose sensor types for each port.

   When using the Em50R, select the radio settings you plan to use (See Chapter 6). Click on "Apply" to save the changes. When using the EM50G, select your communication configurations (see Chapter 4: Software and Configuration).

6. Press the "Disconnect" icon when finished.

## Field Installation

**NOTE:** *To watch a five minute video on installation, visit www.decagon.com/videos.*

The Em50 will serve as a collection station for up to 5 sensors. The Em50 is compatible only with sensors made by Decagon such as the ECH$_2$O water content probes, rain gauge, temperature sensors, etc. To install the Em50 and sensors, do the following:

1. If you are using the Em50R or Em50G, perform a telemetry test to check the wireless signal. If your signal is low or does not exist, move to an alternative location. (Sometimes only a few feet away will be sufficient.)
2. Install your sensors as directed in the respective sensor's manual.
3. Plug the sensor's jack firmly into the Em50 input port.
4. On the top and bottom of the Em50, there are two loopholes. Use these to fasten the Em50 to a mounting post using the included zip-ties or a similar fastener. Make sure it is installed in an upright position, with the 5 input ports underneath. In this position, rain and spray are shed by the enclosure and drip off without affecting the contents of the Em50 enclosure.
5. Configure the Em50 using ECH$_2$O Utility, ECH$_2$O Utility Mobile, or DataTrac.

## Cautions

When you install an Em50 series logger, remember:

- Do not immerse the Em50 in liquids.
- Make sure to install the Em50 upright to reduce the possibility of water entering the Em50 enclosure.
- Do not install Em50R or Em50G wireless loggers near large metallic objects, as these can attenuate the radio signal.

If the Em50R or Em50G is mounted to a metallic post, be sure to use an antenna extension cable to mount the antenna to the top of the post. This will maximize the transmit range of the Em50 wireless transmission.

# 4. Software & Configuration

The Em50 series data loggers were designed to have simple configuration and no data logger programming. The software packages below were designed to fit a variety of users.

- **$ECH_2O$ Utility**--Use $ECH_2O$ Utility for basic data logger configuration and data download in Excel format. For users with a windows laptop, netbook, or desktop computers.

  **$ECH_2O$ Utility cannot download Em50G data from Decagons internet server.*

- **DataTrac**--Use DataTrac for configuring and organizing multiple Em50 series loggers. DataTrac's database system automatically updates newly downloaded data and creates graphs of complete data sets from each logger. This software is best if you are interested in viewing your data on a daily or weekly basis because of the software's ability to automatically append new data collected by each logger.

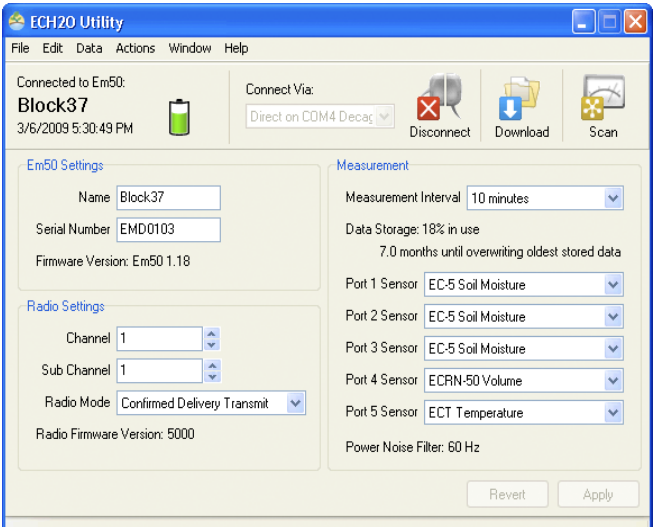
- **$ECH_2O$ Utility Mobile**--Use $ECH_2O$ Utility Mobile to configure and download data on Em50 data loggers when using a handheld device such as an Archer or iPAQ running Windows Mobile.

- **Em50G Downloader**--Use Em50G Downloader when downloading data from the Em50G that is stored to DataTrac using Decagon's Internet Data Service.

DataTrac and $ECH_2O$ Utility Mobile have their own designated manuals. Instructions for $ECH_2O$ Utility and the Em50G Downloader are included here.

# ECH$_2$O Utility

ECH$_2$O Utility provides a user-friendly interface for configuring and downloading data from the Em50 logger. After installing the program (see Chapter 3: Setup and Installation for instructions), launch the program. You will see the main screen:




*The ECH$_2$O Utility Main Screen*

Here you can set all logger configuration parameters with visual controls. At the top of the program window is a toolbar for interacting with the Em50. To the left is a battery indicator. To the right is the "Connect Via" menu, where you can select a COM port; the Connect button (which displays "Disconnect" when you are connected to an Em50); the Download button, which downloads data saved on the Em50 onto your computer; and the Scan button, which scans all of the sensors connected to each port on the Em50, and returns a real-time reading. These functions will be described in detail further in this chap-

ter. Below are the most common tasks that can be performed with the $ECH_2O$ Utility, explained in detail.

## Common Tasks in $ECH_2O$ Utility

Configuring the Em50/Em50R/Em50G

The Em50 doesn't require any programming. It does have several parameters that control identity and function. To change a parameter, connect to your device, change the desired parameter, then click "Apply" to send the parameter changes to your device. Here is a brief description of each:

**Name.** Each Em50 device should have a unique name. The default name is the unit's serial number. You can change this to any legal name you want. A legal device name uses upper and lower case letters, numbers, underscores, and hyphens. Spaces and most punctuation are not legal name characters. $ECH_2O$ Utility prevents you from choosing a name containing illegal characters.

**Serial Number.** When set in the factory, this is a read-only value.

**Measurement Interval**. The Em50 and Em50R loggers allow you to select a measurement interval between 1 and 1440 minutes while the Em50G allows you to set a measurement interval between 5 and 1440 minutes. A measurement interval of zero (0) or "off" stops the logger from making measurements.

**Port Sensors.** The Em50 requires you to identify the sensor type for each of the five sensor ports.

**Cellular Settings.** To turn the cellular network of the Em50G on or off, click the "Configure" button in the "Communication Option" section. The cellular network is active when "Upload

data to $ECH_2O$Data.com" box is checked and is off when the box is not checked. The Em50G is uploading data to the Decagon Data Service ("on") by default. See Chapter 5. Em50G Cellular Communications for more information on the Em50G.

Choose up to six upload times. Default upload times are: 6-7 AM, 10-11 AM, 1-2 PM, 4-5PM. To conserve battery power, choose fewer upload times.

Click "OK" after making configuration changes. Click "Apply" to save communication settings in your Em50G. Your current settings will show up in the communications option field.

$ECH_2O$ Utility helps you evaluate the quality of the cellular connection on your Em50G with the Communication Test feature. Please see Chapter 5. Em50G Cellular Communication for a step-by-step guide to running the Communication Test.

**Radio Settings**. Only devices that have a radio module will support these options (Em50R, DataStation). See Chapter 6: Em50R Radio Telemetry for more information on using the radio settings.

Downloading Data when Directly Connected

Once the Em50 is properly configured and installed, it will begin making and storing sensor measurements. Stored data can be downloaded from the logger starting at two places in the logger's memory. The "Download New" option downloads the data stored since the last successful download. The "Download All" option downloads all the data currently stored in the Em50. The "Download" button on the toolbar corresponds to the "Download New" option. Any model of Em50 data logger

supports downloading data when directly connected to the logger with $ECH_2O$ System software.

To download data, do the following:

1. Use the USB cable to connect the Em50 to your computer.
2. Choose "Direct on" the appropriate COM port from the "Connect Via" drop-down list and press the "Connect" button. If you encounter connection errors, please see Chapter 11: Troubleshooting or the $ECH_2O$ Utility Help File.
3. Once connected to an Em50, either click the "Download" button on the toolbar, or go to the Data Menu and select a download option as described above.
4. When saving data, the File Save dialog suggests a name based on the connected logger's name and the time and date. However, you can enter any name by typing it into the "File name" field.
5. Choose the file format you prefer then click "Save". $ECH_2O$ Utility will download the data and create the file.

$ECH_2O$ Utility can save your data in several different file formats:

- **Excel Workbook File (.xls)**: Converts the raw down-loaded measurement data into engineering values appropriate for each sensor type. The converted data are saved to sheet 1 of the workbook. Raw data are saved to sheet 2. You can use the raw measurement data to apply custom calibration to your sensor data.
- **DataTrac Data File (.dxd)**: Saves the file in a format that DataTrac can import. Each dxd file contains information about the $ECH_2O$ logger's settings, identity, and status along with the raw data for each sensor.

- **Processed Data Text File (.txt)**: Converts the raw down-loaded data into engineering values appropriate for each sensor type. Data are saved as a tab delimited text file.
- **Raw Data (.csv)**: Saves the raw data in the form down-loaded from the logger.

**NOTE:** *The DataTrac file format (.dxd) is a useful way to store data for later manipulation. Each .dxd file contains information about the $ECH_2O$ logger's settings, identity, and status along with the raw data for each sensor. $ECH_2O$ Utility will process a .dxd file into an Excel file or a processed text file. This allows you to re-process your raw data with different settings or file formats as needed.*

Other Data Download Options

An Em50R supports downloading data wirelessly. $ECH_2O$ Utility can establish a two-way radio connection between your computer and a remote Em50R through the Rm1 Radio Modem. Once this connection is established, downloading data from the Em50R is handled just like a download when directly connected to the logger. See Chapter 6. Em50R Radio Telemetry for more information on setting up two-way wireless communications.

The Em50R also supports wireless sensor networks. In this mode, the Em50R transmits measurement data to a DataStation. You can then download the measurement data from all the Em50Rs in your network from one location. See Chapter 6. Em50R Radio Telemetry for more information on setting up logger networks.

The Em50G logger is designed to upload your measurement data to Decagon Data Service using the cellular network. This

makes it easy for you to use the internet to download your measurement data from anywhere in the world. Please see Chapter 5: Em50G Cellular Communications for more information.

**NOTE:** *ECH$_2$O Utility uses the default conversion equation for each sensor when converting raw data to processed data. For more information about the default conversion equations, please see your logger or sensor manual.*

Erasing Data

If you need to erase the data on your Em50, go to Data > Erase Stored Data. You should erase your data if you change the Em50's configuration settings, such as what type of sensor is in each port. After selecting the Erase option, you will be asked if you want to continue. Click Cancel to return to the program, or Erase Data to continue.

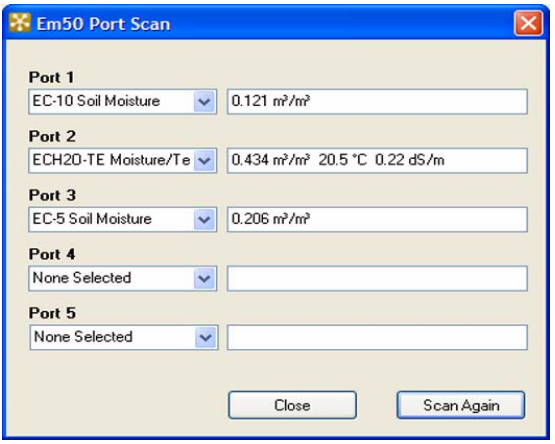
**WARNING! Once this feature is activated, ALL stored data will be erased and cannot be recovered!**

Instantaneous Measurements (Scan)

The ECH$_2$O Utility gives you the ability to take real-time sensor measurements with your Em50 logger. This is most useful as a troubleshooting feature to test if a sensor is reading properly. You can also see how sensors react to environmental changes. To take this type of reading:

1. Click the "Scan" button in the toolbar, or go to Actions > Scan Logger Ports. The Em50 will take a reading on each

of the ports, then display a screen similar to the one below.




2. All 5 ports are displayed, along with the measurement for each port in the units appropriate for the sensor. You can change measurement units in the Preferences Menu (see "Measurement Units" in Chapter 5). Click the sensor's name to see the reading as raw data.

The five ports are displayed, along with the measurement for each port in the current selected unit. If nothing is plugged in to a port, the reading for that port will be zero.

**NOTE**: *Data measured with the scan function will not be stored in the Em50.*

## $ECH_2O$ Utility Menus

The $ECH_2O$ Utility features six menus that allow you to access the program's features. This chapter discusses the features of each menu.

The File Menu

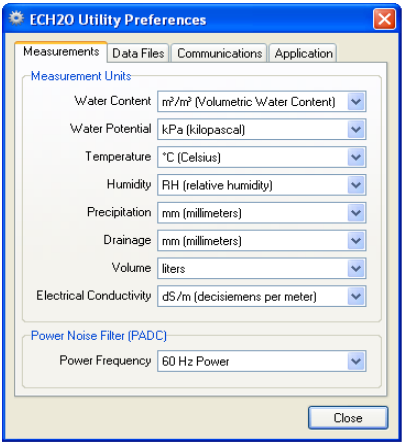
**Save Settings File**. Selecting the "Save Settings File" option from the File menu will create a data file that contains all of the settings and information associated with the connected Em50. This feature is useful for transferring logger configurations between $ECH_2O$ Utility and $ECH_2O$ DataTrac. By default, the name of the settings file is the name of the selected Em50. After naming the file and selecting where it will be saved, click Save to create the file.

**Convert Data File.** $ECH_2O$ Utility will "process" or convert raw $ECH_2O$ sensor data to processed data. This feature works by reading a file containing raw data and outputting the processed data into a different file. You can convert DataTrac data files (*.dxd) and EchoLink download files (*.csv or *.txt). Only files saved with $ECH_2O$ Utility and $ECH_2O$ Utility Mobile can be converted to processed files. You can choose to save your processed files as an Excel file or text file.

Edit Menu

**The Preferences Menu.** The main feature of the Edit Menu is the Preferences menu. The Preferences menu features four tabs for navigation: Measurements, Data Files, Communications, and Application. Below are a list of the most common tasks that can be performed in each tab.

## 1. Measurements Tab



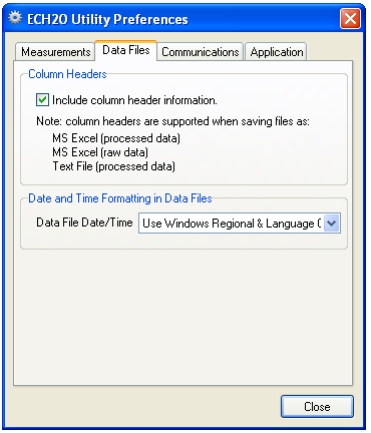

*Measurement Units.* These are the unit values that will be displayed when downloaded data are saved as Excel, processed, or raw data files. $ECH_2O$ Utility supports displaying some measurement data in multiple units. For example, it allows you to choose degree Celsius or degree Fahrenheit for temperature sensors. To set your preferences for measurement units, choose the "Measurements" tab in the $ECH_2O$ Utility Preferences window.

Locate the type of measurement and select a unit from the drop-down menu next to it. Click "Close" to apply the changes.

*Power Noise Filter.* The AC electrical power in your office or home can add a subtle amount of noise to the data logger sensor measurements. The logger's Power Noise Filter setting is designed to eliminate this electrical noise that comes from the AC power distribution system. You should set the value of the Power Noise Filter to match the frequency of the power cycle where you live. In North America and most of Asia, this is 60 Hz (the default value). In most of Europe the electrical frequency is

50 Hz. This feature only needs to be set once, as the program will automatically update the filter of each device that it connects to.

## 2. Data Files Tab

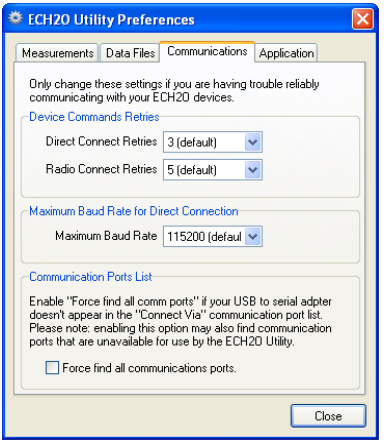



*Column Headers.* The column header gives each column a title corresponding to the port number, measurement type, and unit. Column headers for saved data files are turned on by default, and apply only to processed and raw MS Excel data, as well as processed text data. De-select "Include column headers" to turn off the column headers for these file types.

*Setting Date/Time Format for Data Files.* You can control how the date and time values are formatted in the data file. By default, the time and date are formatted using the settings in the Windows Regional & Language Options control panel. You can modify this to display the date and time in dd/mm/yyyy format with either a 12- or 24-hour clock. To change the format, select an option from the menu, then click "Close" to apply the changes.

## 3. Communications Tab

The Communications preference tab has items that control how the serial communication works between $ECH_2O$ Utility and your Em50. Generally you should not adjust these settings unless you are experiencing problems communicating with your Em50.


ECH2O Utility Preferences
Measurements
Data Files
Communications
Application
Only change these settings if you are having trouble reliably communicating with your ECH2O devices.
Device Commands Retries
Direct Connect Retries
3 (default)
Radio Connect Retries
5 (default)
Maximum Baud Rate for Direct Connection
Maximum Baud Rate
115200 (defaul
Communication Ports List
Enable "Force find all comm ports" if your USB to serial adpter doesn't appear in the "Connect Via" communication port list. Please note: enabling this option may also find communication ports that are unavailable for use by the ECH2O Utility.
Force find all communications ports.
Close

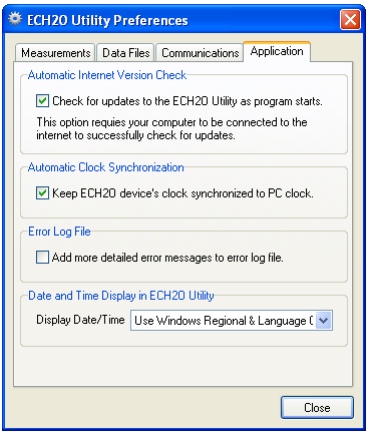
*Direct Command Retries.* $ECH_2O$ Utility automatically retries commands it sends to your Em50 when there are errors. For most circumstances, the default retries work well. If you experience unreliable communication with your Em50, you can try increasing the Direct Connect Retries.

*Maximum Baud Rate.* Set a baud rate lower than the default 115,200 baud if you consistently experience serial connection problems.

*Communications Port List.* $ECH_2O$ Utility is compatible with most USB-to-Serial adapters. Some models of USB-to-Serial adapters are not found by the serial port enumeration feature of

$ECH_2O$ Utility. If your model of USB-to-serial adapter is not recognized, enable "Force find all Communication Ports" in the Preferences Menu by going to the Communication tab, and enabling the check box at the bottom of the screen. Enabling this option may find other serial ports that are not available for use by the $ECH_2O$ Utility (for example, modems installed in your computer).

## 4. Application Tab


ECH2O Utility Preferences
Measurements
Data Files
Communications
Application
Automatic Internet Version Check
Check for updates to the ECH2O Utility as program starts.
This option requies your computer to be connected to the internet to successfully check for updates.
Automatic Clock Synchronization
Keep ECH2O device's clock synchronized to PC clock.
Error Log File
Add more detailed error messages to error log file.
Date and Time Display in ECH2O Utility
Display Date/Time
Use Windows Regional & Language (
Close

*Automatic Internet Version Check.* $ECH_2O$ Utility will automatically check for a newer version using Decagons internet version-check engine. When this option is selected, it will notify you when a newer version is available if you are running $ECH_2O$ Utility, and if your computer is connected to the internet. You can turn off the automatic check by un-checking this option. You can manually check for updates any time using the "Check for $ECH_2O$ Utility Updates" option in the Help menu.

*Automatic Clock Synchronization.* By default, the $ECH_2O$ Utility automatically synchronizes your logger's date and time to

the time set on your computer. You can disable this feature by un-checking this option. You can also update the date and time in your logger any time it is connected by selecting Actions > Set Date/Time.

*Error Log File*. The $ECH_2O$ Utility keeps a log file of errors and events. Adding more messages to this file is useful for troubleshooting. Check this option to add more error and event messages to the error log.

*Date and Time Display in the $ECH_2O$ Utility.* You can control how the date and time for your Em50 is displayed in the toolbar status area. By default, the time and date are formatted using the settings in the Windows Regional & Language Options control panel. You can modify this to display the date and time in dd/mm/yyyy format with either a 12- or 24-hour clock.

Data Menu

The Data menu has three options: **Download New Data, Download All**, and **Erase Stored Data**. For more information on these functions, please refer to their respective sections in Chapter 4.

Actions Menu

**Connect/Disconnect.**

Performs the same function as the connect/disconnect button in the toolbar. It initiates a data communication connection between your Em50 and your computer. You must first connect to your Em50 before downloading data.

Get Settings

This command retrieves all the port and configuration settings from your Em50. These settings are automatically collected

when you connect to your Em50. You can use this option to check to make sure your changes are stored in the Em50.

Apply Settings
Applies the parameters you changed to your Em50. This operates just like the Apply button on the main screen. This option is only available when there are parameter changes available to send to the Em50.

Scan Logger Ports
This option allows you to take readings from each port independent of the others. See the section "Instantaneous Measurements" in Chapter 4 for details and procedures.

Digital Sensor Terminal
The Digital Sensor Terminal is used for SDI-12 addressing and query of our digital SDI-12 sensors. See these sensors' respective manuals for additional information on SDI-12 capabilities.

Set the Date/Time
When you select this action, the ECH$_2$O Utility will set the Em50's time and date to be the same as the time and date on your computer.

Communication Test
When the Em50R or Em50G is connected using ECH$_2$O Utility, use "Communication Test" to see how well your logger's wireless communication is working. If the test suggests that you have a poor connection, you can move to a new location and re-try the communication tests.

Device Tools

The Device Tools submenu contains the following items:

**Test Device Firmware.** This option is useful in determining if you have any firmware (the internal software that runs the Em50) errors. To initiate a firmware test, select Actions > Device Tools > Test Device Firmware. This will automatically test the integrity of your Em50's firmware, and report if it reads as Bad or Good.

**Initialize Radio Module.** Resets the radio module to the default setting. This option applies to Em50Rs and DataStations only.

**Initialize Device.** Initializing your Em50 is a form of a hard reset. ECH$_2$O Utility resets your Em50 and re-writes all the logger settings. All your measurement data is erased. This option is useful for troubleshooting a logger that is not working as expected.

**NOTE:** *Initializing your Em50 will delete all stored data. Make sure any data has been downloaded out of the Em50 before initiating a reset.*

**Window**

The Window Menu contains the Show Terminal command. The terminal window allows you to directly enter commands for your Em50, and is mainly used for troubleshooting and diagnosis.

**Help**

The Help Menu allows access to the ECH$_2$O Utility help file, allows you to check for program and firmware updates, and displays information about your copy of the ECH$_2$O Utility.

ECH$_2$O Utility Help

This menu item opens the help file. It contains some of the information found in this manual.

Send Feedback to Decagon

This menu item helps you send product feedback, bug reports, or feature requests to Decagon. Your computer must be connected to the internet for this feature to work. See Appendix B for more information.

Check for Utility Updates

This function checks for the newest available version of the ECH$_2$O Utility. Make sure you are connected to the internet, then select Help > Check for ECH$_2$O Utility Updates. The program will check to see if there is a newer version available. If there is, it will direct you to the web page where you can download it. To check for a newer version of the ECH$_2$O Utility, choose this menu item. Checking for updates for the ECH$_2$O Utility uses Decagon's version-check web engine. Your computer must be connected to the internet for this feature to work.

Check for Device Firmware Updates

This menu item is only available when you are connected to an Em50 (or other ECH$_2$O device). It compares the firmware version of your Em50 with the latest version available from Decagon. You can download a firmware updater when a new version is available. Your computer must be connected to the internet for this feature to work.

About the ECH$_2$O Utility

This menu item opens the "About" window. You can see the version of your copy of ECH$_2$O Utility here.

## Em50G Downloader

The Em50G Downloader is used to securely connect to Decagon's internet server to download into DataTrac. When you wish to download data from the server, first start the Em50G Downloader then start DataTrac.

Em50G Configurations in Em50G Downloader

After installing the Em50G Downloader, you will first be prompted with User Configurations. Your e-mail and password are used by Decagon to link you to your Em50G data logger(s). The additional information requested will help with support issues, but is not required. After you complete the user configurations, you are ready to add new Em50G loggers to your subscription.

Add a Subscription

In order to view data from an Em50G, you must first "subscribe" to that Em50G. You are not limited by the number of Em50G loggers that you can subscribe to. To subscribe to an Em50G logger:

1. Select "Add Subscription"
2. Enter the "Device ID" and "Device Key" that are on the Em50G information card that came with your Em50G logger. The Device ID and the Device Key are exclusive to each Em50G.
3. Pick the server from which you will retrieve your data. The "EC$H_2O$ Production Server" is the default server and should be used unless specified by Decagon.
4. If you are downloading data from an Em50G that has been logging data prior to the subscription addition, set the

"Retrieve" date for the date that you want to start receiving data from.

All of the Em50G loggers that you have subscribed to will show up in your Em50G downloader page. When you press "Download", data is downloaded from the server for all loggesr that are enabled (checked). The files are saved to the same location where DataTrac files are saved. Files are saved at C:\Documents and Settings/<localusername>\My documents\ ECHO2 Data Trac\Auto Import\" which can be read, processed, and/or removed by current versions of DataTrac.

# 5. Em50G Cellular Communication

The Em50G data logger is equipped with a GSM/GPRS cellular module that enables the logger to upload sensor measurement data to Decagon Data Service. Your measurement data is available for download directly to your Windows computer at any time, anywhere in the world where you have internet access. To extend your service plan ..what??

## Decagon Data Service

The Em50G uses "push" technology to upload measurement and logger status data to the Decagon Data Service on regular intervals each day. This type of "push" technology allows the Em50G to keep its cellular hardware powered off for most of the time allowing long battery life. The logger uses a unique cryptographic signature and checksum to protect the integrity of the your data as it is transferred over the cellular network and internet as it's uploaded to the Decagon Data Service.

The Em50G keeps track of the data successfully uploaded to the Decagon Data Service. If your logger is unable transfer data during one regularly scheduled session, the data is included in the next upload session.

Once stored in the Decagon Data Service, your measurement data is available for download over the internet. Downloading data does not remove it from the Data Service. It is safely stored for download at any time.

## Cellular Service

Decagon makes using the cellular network easy by including the first year of service with the Em50G. Decagon partners with over 200 GSM/GPRS network operators in 120 countries to provide cellular service all over the globe. Decagon has pre-configured your Em50G with an appropriate SIM card for the location where you plan to use your logger. The SIM card and associated service Decagon provides is only for use with the Em50G as outlined by the usage agreement in Appendix C.

**NOTE:** *Please check with Decagon before moving an Em50G from one country to another to make sure your service plan is appropriate for the new location.*

To extend your service plan or to troubleshoot your cellular service, please contact Decagon or the authorized Decagon Distributor where you purchased your Em50G.

## Cellular Coverage

The Em50G requires GSM/GPRS cellular service to upload measurement data to Decagon Data Service. In the USA, the Em50G operates on the T-Mobile and AT&T networks (the Em50G is not compatible with the Verizon or Sprint networks). Outside of the USA, the Em50G should be compatible with technology used by most cellular carriers.

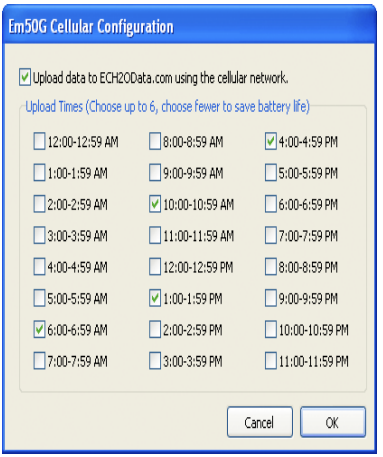
$ECH_2O$ Utility offers a "Communication Test" feature that allows you to evaluate the quality of the cellular network coverage where you plan to install the Em50G. This allows you to evaluate the cellular coverage before installing your logger. Repositioning your logger a short distance may improve your cellular coverage.

For measurement site planning, it may also be useful to consult the network coverage tools offered by each carrier. Please contact Decagon for specific questions about the cellular coverage offered by our partner networks.

In some cases, it may be necessary to use a directional antenna to boost the cellular signal strength of the Em50G to maintain regular data uploads. Please contact Decagon for additional support.

## Em50G Configuration and Settings

The Em50G is configured to upload data to Decagon Data Service right out of the box. To start logging and uploading data, configure your logger with the type of sensors installed in each port and turn on sensor logging by choosing a measurement interval. The Em50G will begin uploading data according to the default schedule (uploading between 6-7 AM, 10-11 AM, 1-2 PM, 4-5PM each day).



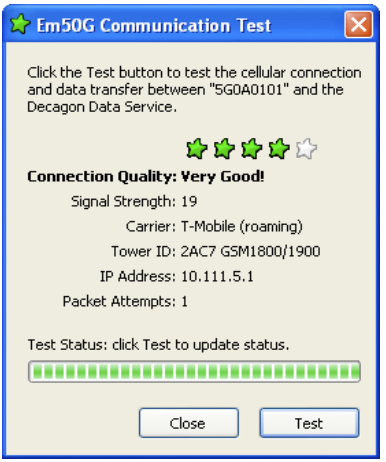
Use $ECH_2O$ Utility to change these default settings. To turn the cellular network of the Em50G on or off or change the upload times, click the "Configure" button in the "Communication Option" section. The cellular network is active when "Upload data to $ECH_2O$Data.com" box is checked and is off when the box is not checked. In this dialog box, you can choose up to six upload times that correspond to the times when you want to the most up-to-date sensor data available for downloading. The Em50G uses a random time within the hour to reduce resource loads on the cellular network and Data Service. To conserve battery power, choose fewer upload times.

Click "OK" after making configuration changes. Click "Apply" to save communication settings in your Em50G. Your current settings will show up in the communications option field.

**NOTE:** *Sensor data recorded by the Em50G while it is configured not to upload data to the Data Service will be stored in the logger, but will not be uploaded to the Data Service. Turning on the upload feature will start uploading data collected on the next measurement interval.*

## Communication Testing

$ECH_2O$ Utility helps you check the quality of the cellular communication of your Em50G using the Communication Test feature. Open the Em50G Communication Test dialog by clicking the "Test" button or choosing "Communications Test…" in the Actions menu.


Em50G Communication Test
Click the Test button to test the cellular connection and data transfer between "5G0A0101" and the Decagon Data Service.
Connection Quality: Very Good!
Signal Strength: 19
Carrier: T-Mobile (roaming)
Tower ID: 2AC7 GSM1800/1900
IP Address: 10.111.5.1
Packet Attempts: 1
Test Status: click Test to update status.
Close
Test

The test takes approximately 30-60 seconds while the Em50G establishes a connection with the cellular network and sends test packets to the Decagon Data Service. Once the tests are finished, the "Connection Quality" field reports connection quality based on cellular signal strength and successful packet transfers. After the initial test is finished, clicking the "Test" button again will update the cellular signal strength and re-send test packets. Subsequent tests are much quicker than the initial test because the Em50G is already connected to the cellular network and the Decagon Data Service. Re-testing your connection quality allows you to find the best spot to install your Em50G. If one test fails, be sure to try the test again.

**NOTE:** *The cellular radio is on while the "Em50G Cellular Test" dialog window is open. Be sure to close the window when you are done testing to preserve battery power.*

If the connection quality of your Em50G is poor, sometimes moving your logger a short distance will improve the signal

strength. Also consider elevating the antenna by elevating the logger or using an antenna extension cable to improve signal strength. In some cases it may be necessary to use directional antennas to have sufficient cellular signal. Please contact Decagon or your Decagon representative for help choosing the correct antenna for cellular frequencies used at your location.

The Communication Test is checking both the cellular signal strength and the connection to the Decagon Data Service. If the Data Service is temporarily unavailable due internet problems, the connection quality will report a failure even if you have strong cellular signal. If your cellular signal strength is good (above '12') then it is reasonable to expect good connection quality once the Em50G can re-connect to the Decagon Data Service.

**NOTE:** *The measurement data collected by your Em50G is automatically queued for the next successful connection to the Decagon Data Service. The integrity and continuity of your data is not affected by short term cellular or internet outages.*

## Downloading Data

You have two options for downloading the sensor measurement data collected by your Em50G.

Direct Download

Like all Em50 loggers, the Em50G stores more than 36,800 sensor readings for each of the 5 sensor ports. You can use any $ECH_2O$ system software to directly connect to the logger for data download. Your data are always safely stored in non-volatile memory as a backup in unlikely event of data loss on your computer. For downloading instructions when directly connected, see "Downloading Data" in Chapter 4.

Internet Downloading

The Em50G and Decagon Data Service make downloading your measurement data over the internet convenient and easy. Use the Em50G Downloader to subscribe to data collected by your Em50G. The Em50G Downloader application is designed to work with DataTrac for data display.

**NOTE:** *$ECH_2O$ Utility does not connect to the Decagon Data Service for downloading data over the internet. You must use the Em50G Downloader application.*

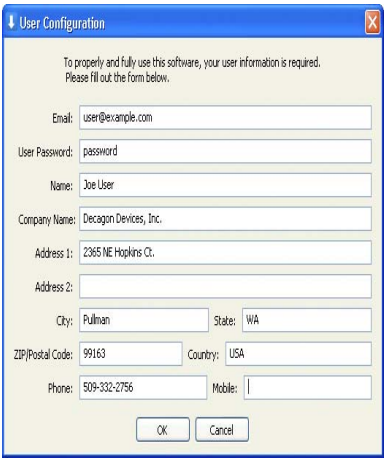
Install the Em50G Downloader application from the install CD that came with your logger. You can also download the latest version from www.decagon.com/support/downloads/.

The Em50G Downloader application is designed to automatically launch DataTrac when it has downloaded new data from the Decagon Data Service. DataTrac is required to run as Administrator to operate correctly on Windows Vista and Windows 7. For the Em50G Downloader to launch DataTrac automatically on these versions of Windows, it should also run as Administrator. To configure Em50G Downloader to run as Administrator, follow these steps:

1. Click the "Start" button. Choose "All Programs" and "Em50G Downloader".
2. Right-click on the "Em50G Downloader" program icon.
3. Choose "Properties" from the pop-up menu. This opens the "Em50G Downloader Properties" dialog.
4. Click on the "Compatibility" tab at the top of the dialog window.

5. Click on "Run this program as an administrator" checkbox.
6. Click the "OK" button to dismiss the properties window.
7. Em50G Downloader can now automatically launch DataTrac without any other user interaction.

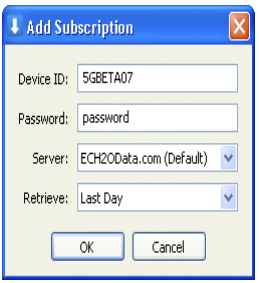
When you first launch the Em50G Downloader application, you are prompted to enter your user contact information. Decagon uses this information to link you to your subscribed Em50G to provide customer support in the event your logger isn't working as expected. You can update this information at any time by choosing "User Configuration" from the Settings menu. Once you've completed the user information, you are ready to add new subscription information.




In order to download data over the internet for a specific logger, you must first "subscribe" to that Em50G logger. You may subscribe to any number of Em50G loggers. Remember that during the subscription process you must be connected to the internet. To subscribe:

1. Click the "Add" button in the Em50G Downloader.
2. Enter the unique "Device ID" and "Password" for your Em50G. You will find this information on the brightly colored card that came with your Em50G logger. Keep this card in a safe place.
3. Make sure the "Server" option is set to "ECH$_2$OData.com (Default)".
4. Pick the amount of data you want to include in the first download. If this is the first time you are downloading data from this logger, you should choose the "All Data Points" option. If you are only interested in downloading data uploaded over the last day or last week, choose "Last Day" or "Last Week" respectively.
5. Click "OK". The Em50G Downloader will communicate with the Decagon Data Service to verify the information you've entered.

Repeat the above steps for each of your Em50G loggers. You can add new logger subscriptions at any time.

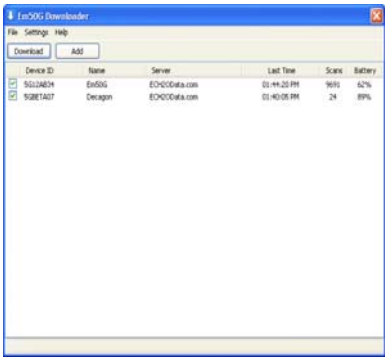



Click the "Download" button to download any new measurement data sent by your Em50G loggers since the last time you downloaded. Data files successfully downloaded for each logger is

saved in DataTrac's auto-import directory (My Documents\ $ECH_2O$ DataTrac\AutoImport\). When DataTrac launches, it automatically process the files in this directory by appending this data to the appropriate logger.

**NOTE:** *DataTrac will list loggers in the "New Devices" section by the logger name when it encounters a logger it hasn't seen before. Select your Em50G by its name, and choose the "Configure" button on the DataTrac toolbar. Set the location information if desired, then press "OK".*

The Em50G Downloader application is configured by default to automatically start a download when launched. It also automatically restarts DataTrac after a successful download. This is designed to reduce the number of actions necessary to retrieve and view data collected by your Em50G logger. You can adjust this setting by choosing "Preferences" from the Settings menu of the Em50G Downloader application.




The Em50G Downloader application main window shows the user-set name, download server, and battery status for each Em50G logger. It also shows the last time you downloaded

data from the Decagon Data Service with the number of measurement "Scans" included in the download. If the value for "Scans" is zero, it means the logger hasn't uploaded any new data since the last time you downloaded data. Please try your download again later. If you are unable to download new data when expected, please contact Decagon or your Decagon representative for support. If there are specific times during the day you want to download the latest data, please make sure your Em50G is configured to upload data during the previous hour.

Managing subscriptions. The Em50G Downloader application attempts to download data from each logger that is checked in the main window. If you want to temporarily ignore a logger during download sessions, simply click the checkbox next to the appropriate logger to uncheck. If you want to stop subscribing from a logger permanently, select the logger in the list and choose "Delete Subscription" from the File menu.

## Sharing Data

The Em50G and Decagon Data Service also make it easy to share your measurement data with a colleague or collaborator. You control who has access to specific Em50G data by providing the unique Device ID and Password pair associated with each logger (found on the brightly colored card shipped with each Em50G).

**NOTE:** *You should keep the Em50G Device ID and Password card in a safe place. Don't leave it inside the Em50G logger case. Only share the information on the card with people you wish to have access to the data published by your Em50G logger.*

There is no limit to the number of people who can subscribe to each Em50G. Each subscriber runs their own copy of the Em50G Downloader application and DataTrac. The tools make sure each subscriber downloads new data since their last download. One subscriber's downloads does not interfere with another subscriber's downloads.

**NOTE:** *For information about improving the range of your radio network, see the section on Radio Performance in Chapter 6.*

# 6. Em50R Radio Telemetry

This chapter gives you a brief overview of the radio telemetry available in the $ECH_2O$ system. This information only applies to Em50R. The $ECH_2O$ system supports two types of radio telemetry: "Two-way" modes and "Transmit" modes. Consider one or both types of radio modes when designing your $ECH_2O$ telemetry system. The "Confirm Delivery Transmit" mode ensure the most complete data transfer and the best battery life. However, there are some unique cases where you may want to use the other available modes.

**NOTE:** *To utilitze the radio communication capabilities of the Em50R, you will also need either a DataStation or an Rm-1.*

$ECH_2O$ telemetry networks require each remote radio logger to have a unique name. Each logger leaves the factory with the name set to the logger's unique serial number. You can easily change the name of the logger to help you identify or organize your data. You should not give two loggers the same name. Two loggers with the same name will interfere with each other when communicating over the radio.

## Transmit Radio Telemetry

The Transmit Radio modes help you create a simple network of remote radio loggers all transmitting data to a DataStation radio base station. The DataStation stores data from all the remote loggers in one convenient place. Typically, a DataStation is connected to your computer where you can easily download the data for use in $ECH_2O$ DataTrac. Unlike the Two-way

Radio modes, you can't remotely change logger settings when using this mode.

When a logger is in Transmit mode, it only turns on the radio when it has new data to broadcast. For example, when you set the measurement interval in your logger to 60 minutes, the logger stores your data every hour and then broadcasts the data to a listening DataStation. The actual transmit time is randomly delayed for several minutes to prevent two or more radio loggers from interfering with each other.

The Transmit radio modes use less battery power because the radio is off most of the time. The Em50R is designed to work approximately 12 months in Transmit mode.

**NOTE:** *A DataStation is a receiver. It doesn't cause the remote logger to send data. If your DataStation is powered off for some time, it won't receive data sent by the remote loggers. However, the missing data is still stored in the logger. You can directly connect to the logger to download the missing data.*

Transmit Radio Modes

Use the Radio Tab in the logger settings form to choose one of the following radio modes that support Transmit communication.

**Confirmed Delivery Transmit:** This is the recommended mode since it is the most robust Transmit radio mode. The radio logger adds a checksum to the data packet before broadcasting the data to a DataStation. The logger then waits for the DataStation to confirm it correctly received the data packet. If the logger doesn't hear the confirmation, it retries sending the packet again. The logger stops trying to transmit to a DataStation after 25 attempts.

**Transmit Only:** This is the original Transmit radio mode. It doesn't offer the advantages of the Confirmed Delivery Transmit mode. You should use the Confirmed Delivery mode when possible. Em5R (discontinued) loggers only support this Transmit radio mode.

**Transmit + Two-way** and **CD Transmit + Two-way:** These modes combine the Two-way Radio mode and the Transmit Radio mode. You could use these modes while configuring and testing your radio network. You should not leave your radio logger in these modes because they use the most battery power of all the radio modes. Using Transmit + Two-way and CD Transmit + Two-way radio modes with the wake interval set to 1 or 2 will cause the batteries of your logger to drain very rapidly.

Transmit Best Practices

Transmit modes are most useful when you have three or more loggers installed within radio range of each other. There is no set limit to the number of radio loggers broadcasting to a DataStation. Use this mode for as few as one logger and as many as 50 or more loggers. You should use the Telemetry Test feature of ECH$_2$O Utility to test the connection from your logger to the DataStation.

**NOTE:** *Em50R loggers must have firmware version 1.12 or later to enable the Confirmed Delivery Transmit mode and Telemetry Test feature. Your DataStation must have firmware version 1.09 or later to receive Confirmed Delivery Transmit mode data packets. Contact Decagon for an application note that covers the steps needed to upgrade your hardware.*

See section on DataStation Networks for step by step instructions for configuring your DataStation and remote radio loggers.

## Two-way Radio Telemetry

The Two-way Telemetry Mode lets you establish a two-way connection with a remote radio logger. Once connected to the remote logger, you can download data and change most settings just like you were connected directly to the logger with a serial cable. Communicating with a remote radio logger requires you to have a Rm1 radio modem connected to your computer. Connecting to the remote radio logger happens through the Rm1.

When a logger is in a Two-way Radio Mode, it turns on its radio every 45 seconds. While the radio is on, the logger listens for connection attempts from a Rm1. If the logger doesn't hear any connection attempts, it turns off the radio. If the logger hears a connection attempt, it leaves the radio on for several seconds listening for login commands from $ECH_2O$ Utility. It takes up to 60 seconds to connect to the remote logger.

When you are finished interacting with the remote radio logger, you press the disconnect button. $ECH_2O$ Utility sends a "logout" command to the remote logger to indicate the end of the communication session. When the remote logger hears the "logout" command, it waits for 10 minutes before listening for additional connection attempts via the radio (you can always direct connect to your logger). This allows you to connect to other loggers with the same radio settings. Otherwise, the first logger you contacted may reconnect. This would prevent you from connecting to your other loggers.

The Two-way modes generally consume the most power. The Em50R is designed to work for several months in the Two-way modes.

Two-way Radio Modes

Use the Radio settings section of $ECH_2O$ Utility to choose one of the following radio modes that support two-way communication.

**Two-way 24-hour**: The radio logger listens for connection attempts every 45 seconds, 24 hours a day. This mode uses a substantial amount of batter power. Expect batteries to last for approximately 3 months.

**Two-way 6:00-18:00**: The radio logger listens for connection attempts every 45 seconds between 6 AM and 6 PM. The logger doesn't use the radio between 6 PM and 6 AM to conserve battery power, by not listening for connection attempts during the night. Expect batteries to last for approximately 6 months in this mode.

**Transmit + Two-way** and **CD Transmit + Two-way**: These modes combine the Two-way Radio modes and the Transmit Radio modes. You could use these modes while configuring and testing your radio network. You should not leave your radio logger in these modes because they use the most battery power of all the radio modes. Expect batteries to last for approximately 3 months in this mode.

**NOTE:** *Using Transmit + Two-way and CD Transmit + Two-way radio modes with the wake interval set to 1 or 2 will cause the batteries of your logger to drain very rapidly.*

Two-way Best Practices

Two-way modes are most useful when you have a small number (one, two, or three) of remote radio loggers you wish to contact. If you have three or more loggers installed within radio range of each other, consider using one of the Transmit modes. The Two-way modes also allow you to mount an Rm1 in your vehicle and interact with the remote logger while in radio range.

See section on Connecting via a Radio Modem for step by step instructions for establishing a two-way connection with a remote radio logger.

## Radio Settings

For two radio devices to communicate they must share the same radio settings. An Rm1 radio modem can only connect to a remote radio logger with the same radio settings. A DataStation will only receive data from loggers with the same radio settings as the DataStation. Set the Radio Channel to the same value for all the devices on the same network. Set the Radio Sub Channel to the same value for all the devices on the same network.

Radio logger networks with different values set for the Radio Channel use different frequency-hopping sequences, and therefore experience minimal interference between groups. Radio logger networks with the same Radio Channel value but different Radio Sub Channel values can interfere with each other, but can't communicate with each other. This interference can also cause additional battery drain in the radio logger.

The default values for Radio Channel and Sub Channel are zero. Use $ECH_2O$ Utility to choose other values.

## Radio Performance

The maximum range of the radio modules in the radio logger and DataStation are affected by the environment, installation method, and antenna choice. Maximizing the range of your radio network requires you to consider all of these factors.

Buildings, hills, vegetation, vehicles and other environmental obstructions will shorten the radio's range – sometimes drastically. You should ensure a clear, open path between radio devices. Also, radio frequency (RF) interference in the environment around the radio can reduce the usable range (even if not using the same radio frequencies). You should consider nearby growing vegetation when designing and testing your radio network. Some radio networks work fine when the vegetation is sparse, yet may fail when vegetation is full.

You can increase the effective transmit range by maximizing the height above ground of the radio antenna. This helps ensure a clear path for the radio signals and reduces the amount of signal absorbed by the earth. Use an antenna extension cable to help you position your antenna when it isn't practical to install your logger higher off the ground. If you mount your radio logger to a metal pole, you should mount your antenna to the top of the metal pole so it is free to radiate the signal above the pole.

Replacing the stock antenna on your radio device with a high-gain antenna can greatly increase the radio range. Consider using a directional Yagi antenna or a high-gain omni-directional antenna when you want to extend the range of your radio

network. A high-gain antenna can also help overcome the effects of unavoidable environmental obstructions.

The $ECH_2O$ telemetry system also supports a simple relay for use with Transmit Mode networks. Combining a relay and high-gain antennas allows radio devices to communicate over very long distances. Contact Decagon for more information on using a relay in your radio network.

## Connecting via Rm-1 Radio Modem

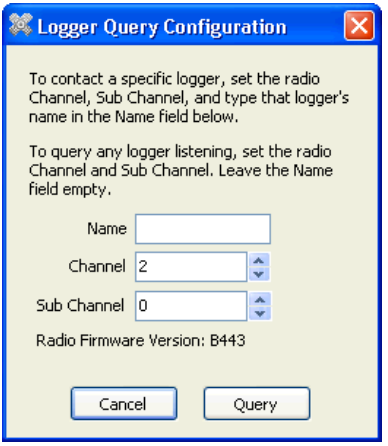
Connecting to an Em50R via a Rm1 is different than connecting via your USB cable. Keep notes concerning the Em50R name and radio settings to make the rest of the system configuration easier to accomplish.

Before you can use the telemetry options of your Em50R, you must configure the Em50R by connecting it directly to your computer using your USB cable. Connect using $ECH_2O$ Utility or DataTrac and set the Em50R's Channel, Sub Channel, and Radio Mode. See the section on Configuring in $ECH_2O$ Utility for additional information on configuring the Em50 series loggers. The Channel can be set from 0 to 6 inclusive (default is 0). The Sub Channel can be set from 0 to 65534 inclusive (default is 0). To use the radio logger with an Rm1, the Radio Mode has to be set to one of the Two-way modes.

If the Two-way 6:00-18:00 mode is chosen, then connection via the Rm1 can only take place between the hours of 6:00 AM through 6:00 PM. This mode was designed to improve battery life by not keeping the radio on constantly. The other Two-way modes can be connected to 24 hours a day.

After setting the Radio Mode, click the "Apply" button in $ECH_2O$ Utility. Disconnect from the Em50R logger. Now, connect your computer to the Rm1 by using a standard 9-pin serial cable. (A USB version of the Rm1 is also available.)

Choose the correct communication port in the "Connect Via" drop-down menu. For example, if your Rm1 is physically connected to your computers COM1 communication port, you would choose "Rm1 on COM1 Communication Port" in the "Connect Via" menu. Click the "Connect" button.


Logger Query Configuration
To contact a specific logger, set the radio Channel, Sub Channel, and type that logger's name in the Name field below.
To query any logger listening, set the radio Channel and Sub Channel. Leave the Name field empty.
Name
Channel
2
Sub Channel
0
Radio Firmware Version: B443
Cancel
Query

The Logger Query Configuration form will appear. To connect to a specific Em50R, type the logger's Name, Channel, and Sub Channel. After typing the name, click the Query button. If you want to connect to any available Em50R, pick the correct Channel and Sub Channel, but leave the Name field blank.

**NOTE:** *To connect to a radio logger, the radio Channel setting must be the same for both the logger and the Rm1. The radio Sub Channel setting must also be the same for both the logger and the Rm1.*

The Connection Progress screen appears as $ECH_2O$ Utility tries to establish a radio connection with the remote logger through the Rm1. The connection process can take up to 60 seconds while $ECH_2O$ Utility sends a logger "wake up" signal and retries the connection attempt.

When $ECH_2O$ Utility connects to a remote radio logger, it shows the signal strength of the connection with the radio signal strength icon on the status bar. Click on the radio signal strength icon to see the signal strength percent in the message area.

See Chapter 9: Troubleshooting if $ECH_2O$ Utility fails to connect to your remote logger.

Once $ECH_2O$ Utility establishes a two-way radio connection with a remote logger, you can interact with the logger just like a direct connection.

**NOTE:** *You cannot change the radio Channel or radio Sub Channel settings in the remote logger while connected via the Rm1.*

## DataStation Networks

Configure a DataStation

After establishing a connection set the Channel and Sub Channel. Channel can be set from 0 to 6 inclusive (default is 0). The Sub Channel can be set from 0 to 65534 inclusive (default is 0).

Note the Channel and Sub Channel settings chosen. Click the "Apply" button to save the settings to the DataStation. For easy

data downloading and telemetry testing, leave the DataStation plugged into your computer and your powered at all times.

Configure an Em50R Logger for use with the DataStation

To use one or more Em50R loggers with a DataStation the Radio Mode has to be set to one of the Transmit modes. We recommend the "Confirm Delivery" transmit mode.

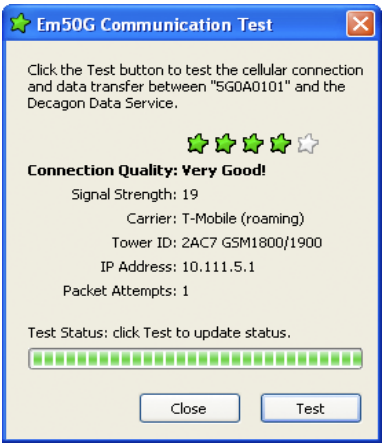
Connect the Em50R to your computer or handheld device using the appropriate cable. Start ECH$_2$O Utility, ECH$_2$O Utility Mobile or DataTrac. Once you're connected, set the radio Channel and Sub Channel settings to exactly the values chosen for the DataStation previously. Set the Radio Mode to Confirmed Delivery Transmit. This mode provides a method for confirming the delivery of the data which greatly increases the ability of the system to successfully transfer the data. The Transmit + Two-way modes are there for use as troubleshooting aids. Set the measurement interval and pick the sensors that will be plugged into each port. See the section on Configuring in ECH$_2$O Utility for additional details on configuring the Em50 series. After setting the Radio Mode, click the "Apply" button.

**NOTE***: ECH$_2$O Utility only shows the radio modes compatible with your radio logger model and firmware version. If you don't see the "Confirmed Delivery Transmit" radio mode option, then your radio logger may not support this option. If you are using an Em50R logger you will need to update the firmware to version 1.12 or newer. Visit www.decagon.com/support/downloads for the most current firmware and software modes.*

## Communication Test

Before finding a permanent location for your Em50R, perform a communication test to verify the quality of the radio communication. However, make sure your DataStation is properly configured and powered during your communication test.

In your field area, connect your Em50R to either a laptop or handheld device using the appropriate cable and press connect. Ensure that your radio channel and subchannel as well as your transmit mode are the same as your DataStation. Choose "Communication Test" from the Actions Menu.


Em50G Communication Test
Click the Test button to test the cellular connection and data transfer between "5G0A0101" and the Decagon Data Service.
Connection Quality: Very Good!
Signal Strength: 19
Carrier: T-Mobile (roaming)
Tower ID: 2AC7 GSM1800/1900
IP Address: 10.111.5.1
Packet Attempts: 1
Test Status: click Test to update status.
Close
Test

Click the Test button and the test will begin. When the test has finished you will be presented with the results of the test. Five stars signifies excellent communication. One star means that all of your data are being transmitted, but multiple tries are necessary. The more attempts to send data means more power is used. Therefore, one star is adequate for data transmission, but will decrease battery life.

You may have to relocate the radio logger while doing the Telemetry Test in order to find the best connection quality.

Once you have found the radio logger location that provides the best connection quality, install the radio logger at that location.

**NOTE:** *Telemetry Test only works with Em50 loggers running firmware 1.12 or newer.*

## Download Collected Data

After the DataStation is configured, it will automatically collect data from Em50R loggers within range and sharing the same channel and sub channel. After data is collected, you can retrieve the data for permanent storage and analysis. DataTrac is best suited for this application.

To download and view data from the DataStation, start DataTrac. In the DataTrac menu, pick the DataStation you want to connect to and click "connect." Click the "Download New Data" button. The Downloading DataStation Data screen will appear and provides a progress bar displaying the download progress.

## Data Processing

DataTrac automatically sorts the data collected by the DataStation and associates the data with the correct logger. However, unless you used DataTrac to also configure your Em50R loggers, DataTrac will not know your logger's name and which sensors are plugged into each port. To add this information to your data set, click on the appropriate Em50R in the logger tree and select "Configure."

If DataTrac is not an option, $ECH_2O$ Utility can be used to retrieve data from your DataStation. $ECH_2O$ Utility gives you several choices for the file type when downloading data from a

DataStation. See Chapter 5: Using $ECH_2O$ Utility, for more information. If you choose processed or raw data file formats, $ECH_2O$ Utility walks you through processing the data for each logger it recorded data for. It prompts you for the logger type and sensor types for each logger. This information is necessary for $ECH_2O$ Utility to process the data correctly.

# 7. Compatible Sensors

The Em50 logger is only compatible with sensors made by Decagon. This chapter gives a brief description of each sensor's function. For more information on each of the described probes, please see that probe's respective operator's manual.

$ECH_2O$ Utility normally converts the raw data recorded by the Em50 into engineering units appropriate for the sensor when downloading data. $ECH_2O$ Utility uses the default conversion equations for each sensor and does not support user-specific calibration. You can choose to download your data in raw format with $ECH_2O$ Utility (see Chapter 4: Using $ECH_2O$ Utility).

Once you have obtained your raw data, you can use a spreadsheet program to apply your own calibration or conversion equations. DataTra software has additional factory calibration options as well as custom calibration options. This chapter lists the default conversion equations for each sensor type. Use these equations as a starting point for your own custom equations.

## Soil Moisture Sensors

### EC-10, 10HS, EC-20, EC-5, EC-TM, 5TM, $ECH_2O$-TE & 5TE

The Decagon soil moisture sensors measure the dielectric constant of the soil to determine the volumetric water content of the soil. Since the dielectric constant of water is much higher than that of air or soil minerals, the dielectric constant of the soil is a sensitive measure of water content. In addition to soil water content, the 5TE is designed to measure electrical con-

ductivity and temperature of growing media and soil. The 5TM is the same design as the 5TE and measures water content and temperature. The 5TE is a redesign of the $ECH_2O$-TE. All $ECH_2O$ probes have a very low power requirement and high resolution.

Default Conversion Equations

$ECH_2O$ Utility uses mineral soil equations for the $ECH_2O$ probes. $ECH_2O$ DataTrac offers conversion equations for potting soil, rockwool, and custom calibration.

**EC-5:**
*Mineral Soil:* $\theta = 8.5x10^{-4} * RAW - 0.481$
*Potting Soil:* $\theta = 7.2x10^{-4} * RAW - 0.393$
*Rockwool:*
$\theta = 6.28x10^{-7} * RAW^2 + 1.37x10^{-4} * RAW - 0.183$

**EC-10:**
*Mineral Soil:* $\theta = 5.71x10^{-4} * RAW - 0.376$

**10HS:**
*Mineral Soil:*
$\theta = 3.13x10^{-7} * RAW^2 - 1.47x10^{-4} * RAW - 5.8x10^{-2}$

**EC-20:**
*Mineral Soil:* $\theta = 4.24x10^{-4} * RAW - 0.29$

**$ECH_2O$-TE/EC-TM:**
*Mineral soil:* $\theta = 1.09x10^{-3} * RAW - 0.629$
*Potting soil:* $\theta = 1.04x10^{-3} * RAW - 0.499$
*Rockwool:*
$\theta = 5.15x10^{-8} * RAW_\theta^2 + 1.41x10^{-7}4 * RAW_\theta - 0.16$

**5TE**
*Mineral Soil* $\theta = -5.3x10^{-2} + 2.92x10^{-2}*\varepsilon - 5.5x10^{-4} * \varepsilon^2 + 4.3x10^{-6}*\varepsilon^3$
Where ε = dielectric
ε = 2* RAW/100

**5TM**
*Mineral Soil* $\theta = -5.3x10^{-2} + 2.92x10^{-2}*\varepsilon - 5.5x10^{-4} * \varepsilon^2 + 4.3x10^{-6}*\varepsilon^3$
Where ε = dielectric
ε = 2* RAW/100

The $ECH_2O$ probes can be used with any port on the Em50.

**MPS-1 Dielectric Water Potential Sensor**
$\Psi m(kPa) = -exp(6.43x10^{-6}*RAW^2 - 3.10x10^{-2}*RAW + 39.4)$

## ECT Temperature Sensor

The $ECH_2O$ Temperature sensor is for use in soil or in the air. It can be connected directly to any channel in the Em50 or Em50R for long-term monitoring of temperature. If you are using the $ECH_2O$ Temperature sensor in air, we strongly recommend that you use it in a radiation shield. Decagon has a radiation shield that can be used with the ECT. If you would like to purchase one, please contact us.

Default Conversion Equation
The default conversion equation for the ECT first calculates an intermediate value with a log transform (natural log), then the temperature in °C from a 3rd-order polynomial:

$$x = \ln\left(\left(\frac{4095}{RAW}\right) - 1\right)$$

$$°C = 25.02 + x(-22.84 + x(1.532 + (-0.08372x)))$$

This equation offers 0.5 °C accuracy in the range of -40° C to + 60° C.

The ECT temperature sensor can be used with any port on the Em50.

## ECRN-50 and ECRN-100

## Rain Gauges

The ECRN-50 and ECRN-100 are simple self-emptying electronic rain gauges. They are made of durable, weather-resistant plastic that is UV-resistant.

The ECRN-50 is best used for measuring irrigation events. This sensor has a resolution of 1 mm. You can configure the Em50 to treat the data collected by the ECRN-50 as standard precipitation or as volume data. Configured as volume gauges, they are useful for measuring the output of irrigation systems in terms of gallons (or liters) per hour

The ECRN-100 is a high-resolution rain gauge with a 0.2 mm resolution.

**NOTE:** *The older model ECRN Rain Gauge used with Em5 loggers is not compatible with the Em50. Please contact Decagon for an ECRN upgrade kit that will allow you to use it with the Em50.*

Default Conversion Equations

The Em50 uses an accumulating counter for storing rain gauge tip events. To calculate the number of tips for one time interval (interval n), you compare it to the previous interval (interval n-1).

$tips = RAW_n - RAW_{n-1}$ for $RAW_n \geq RAW_{n-1}$
$tips = RAW_n$ for $RAW_{n-1} = 0$

ECRN-50 precipitation is 1 mm per tip; volume is 5 mL per tip.

ECRN-100 precipitation is 0.2 mm per tip.

The ECRN-50 and ECRN-100 can be used with any port on the Em50.

## G1 Drain Gauge

Decagon's Drain Gauge is an instrument that is designed for long-term monitoring of water movement and chemical leaching below the root zone. Select "G1 Drain Gauge" when configuring the probe in the $ECH_2O$ Utility and DataTrac.

Default Conversion Equation

The Drain Gauge contains a tip reservoir and a water level sensor. When the reservoir fills and auto-siphons, the level sensor records that data as a *tip* (1mm per tip). The Em50 records the level of the tip reservoir as fractions of a tip (fractions of a mm). The Em50 uses an accumulating counter to store Drain Gauge tips. To calculate the number of tips for one time interval (interval n), you compare it to the previous interval (interval n-1).

raw tips = $RAW_n - RAW_{n-1}$ for $RAW_n \geq RAW_{n-1}$
raw tips = $RAW_n$ for $RAW_{n-1} = 0$

tips (mm) = raw tips/10

Em50 firmware version 1.10 and newer also record the raw analog output of the level sensor at the measurement interval.

This raw output is useful for troubleshooting Drain Gauge problems. ECH$_2$O Utility automatically adds a column for raw data if your Em50 supports this additional data type.

The ECRN-50 can be used with any port on the Em50.

## PYR Solar Radiation Sensor

The PYR Solar Radiation Sensor (pyronometer) measures solar radiation in W/m$^2$. This sensor features a self-cleaning dome-shaped head which prevents water accumulation and is designed for continuous outdoor use. Small changes in the level of the PYR sensor can also cause large measurement errors. Make sure that the top of the domed sensor body is kept horizontal. Use the included leveling plate to ensure the sensor is level.

**NOTE**: *You must have Em50 firmware 1.12 or newer to correctly measure the PYR sensor.*

### Default Conversion Equation

W/m$^2$ = 1.83 * RAW

The PYR Solar Radiation sensor can be used in any port on the Em50.

## QSO-S PAR Photon Flux Sensor

The PAR Photon Flux sensor measures the Photosynthetic Photon Flux (PPF) in µmol/m$^2$s, from a field of view of 180 degrees. Decagon's PAR Photon Flux sensor is completely water proof, submersible, and designed for continous outdoor use.

The cosine-corrected head has a domed diffusion disk for improved self-cleaning. The diffusion disk is composed of

characterized pigments for improved spectral response. Accurate measurement depends on cleanliness of the lens, and installation at horizontal (180$^{o}$). A leveling plate is included for accurate installation.

**NOTE**: *You must have Em50 firmware 1.12 or newer to correctly measure the PYR sensor.*

### Default Conversion Equation

µmol/m$^2$s = 1.83 * RAW

The PAR Photon Flux sensor can be used in any port on the Em50.

## PS-1 Pressure Switch

The ECH$_2$O PS-1 Pressure Switch monitors whether a pressurized irrigation system is either on or off, using a minimum pressure of 5 p.s.i. Growers keeping tabs on crop irrigation, for example, would insert the pressure switch into a pipe in the system, and connect the pressure switch to the Em50. The pressure switch then displays an ON or OFF value in ECH$_2$O Utility. If the water flow is above 5 p.s.i., the switch records ON; but if it is lower, the switch records OFF. This allows the user to monitor whether or not the irrigation system has been running for a desired time interval.

### Deafult Conversion Equation

The Em50 uses an accumulating counter for storing PS-1 Pressure Switch events. The pressure switch records the time the switch is actuated during the measurement interval. The time resolution is 1 minute.

To calculate the amount of time the switch is actuated for one time interval (interval n), you compare it to the previous interval (interval n-1).

minutes = $RAW_n$ - $RAW_{n-1}$ for $RAW_n \geq RAW_{n-1}$
minutes = $RAW_n$ for $RAW_n$-1 = 0

The PS-1 Pressure Switch can be used with any port on the Em50.

**NOTE:** *You must have Em50 firmware version 1.10 or higher to use the pressure switch.*

## EHT Temperature/RH Sensor

The $ECH_2O$ Temperature/RH sensor is a digital sensor designed to measure temperature and relative humidity. Select "EHT RH/Temp" when configuring the probe in the $ECH_2O$ Utility.

$ECH_2O$ Utility saves the raw data for temperature and humidity in their own data columns.

Temp (°C) = 0.040 * $RAW_T$ - 39.55
RH=0.01*(-4.0+($RAW_{RH}$*(0.648-0.00072 *$RAW_{RH}$)+(Temp-25.0)*(0.01+0.00128*$RAW_{RH}$)))

The $ECH_2O$ Temperature/RH sensor can be used with any port on the Em50.

## Millivolt Sensor

Many of the above analog sensors can also be read in millivolt mode. For example, if an EC-5 soil moisture sensor is connected and you wanted to see the millivolt output in processed

data files, you would specify that port as having a Millivolt Sensor connected.

**NOTE***: This only works with analog sensors, not digital sensors such as the ECH$_2$O-TE, EC-TM, or Temperature/RH sensor.*

Default Conversion Equation
millivolts = RAW * (3000/4096)

## LWS Leaf Wetness Sensor

The Leaf Wetness Sensor measures surface wetness by measuring the dielectric constant of a zone of influence on its upper surface. This sensor also has very high resolution, which gives you the ability to detect very small amounts of water (or ice) on the sensor surface. The sensor does not need to be painted before use, which eliminates the need for individual sensor calibration. Select "ELW Leaf Wetness" when configuring the probe in the ECH$_2$O Utility.

The Em50 firmware automatically records the number of minutes the LWS sensor is above the 450 and 460 threshold values. The Em50 also records a single analog raw value at the measurement interval. The raw data download puts each of these measurement types in a single column. The Em50 uses an accumulating counter to store the number of minutes for each threshold. To calculate the number of minutes the LWS was wet for one time interval (interval n), you compare it to the previous interval (interval n-1).

$$\text{minutes} = RAW_n - RAW_{n-1}$$
$$\text{for } RAW_n \geq RAW_{n-1}$$

$$\text{minutes} = (2048 - RAW_{n-1}) + RAW_n$$

for $RAW_n < RAW_{n-1}$

The LWS Leaf Wetness sensor can be used with any port on the Em50.

## Davis Cup Anemometer

The Davis Cup anemometer includes both wind speed (using wind cups and a magnetic switch) and wind direction (with wind vane and potentiometer).

**NOTE:** *The cup anemometer can not be used with DataTrac. We strongly urge you not to use the cup anemometer with the Em50G.*

The value of the wind potentiometer (direction) and number of pulse counts (magnitude) are used to resolve the wind direction into X and Y vector components. The vector components from multiple 1-minute readings are summed together. The X and Y components are recombined to store the "dominant" or "weighted average" wind direction for the measurement interval.

**NOTE***: When there is no wind, the vector math for direction will resolve to zero (North) - regardless of the actual direction of the wind vain.*

The Em50 integrates wind speed pulses for one minute. The highest 1-minute counts in each measurement interval becomes the value for the gusts data. The average of the 1-minute counts becomes the average speed for each measurement interval. The Em50 divides these values by 6 to get tenths of pulses per second or deci-pulses per second (facilitates resolving 0.1 m/s).

$ECH_2O$ Wind Speed (m/s) = 1.006 * deci-pulses / 10

# 8. Caring for the Em50

## Replacing the Batteries

If installed correctly, the Em50 requires little maintenance. The main requirement is that batteries need to be replaced when their charge becomes too low. When the battery life indicator in $ECH_2O$ Utility shows your Em50's batteries are less than 5%, you need to replace them.

**NOTE:** *Installing or changing the batteries in your Em50 resets the internal real-time clock. You must connect to your Em50 using any $ECH_2O$ system software to reset the logger's clock immediately after changing the batteries. If you don't set the logger's clock, the time and date associated with each measurement will be incorrect.*

## Long-Term Maintenance

When caring for the Em50 over an extended period of time, be sure to do the following periodically:

1. Check the battery holders and make sure they are clean and free of corrosion.
2. Check that the sensor ports are clean, and that the sensors are making good contact with the ports.
3. Check case gaskets and sensor cable strain relief.

# 9. Troubleshooting

Although the Em50 has been designed for durability and built to the highest manufacturing standards, problems may occasionally occur. This chapter details the most common problems that you may encounter, and their solutions. If you have a problem not described here or that this section cannot remedy, contact Decagon at 1-800-755-2751 or email us at support@decagon.com.

## Troubleshooting Serial Ports

**PROBLEM:** The $ECH_2O$ Utility tells me the communication port I want to use is in use by another application, but I don't think any other programs are running.

**SOLUTION:** Some PDA synchronization programs monitor serial communication ports. Disable Microsoft's ActiveSync or Palm's HotSync system software while trying to use the serial port with the $ECH_2O$ Utility.

**PROBLEM**: My USB to Serial adapter is not showing in the communication port picker.

**SOLUTION:** Enable "Force find all Communication Ports" in the Preferences Menu by going to the Edit Menu, clicking Preferences, then the Communication tab, and enabling the check box at the bottom of the screen. Enabling this option may find other serial ports that are not available for use by the $ECH_2O$ Utility (for example, modems installed in your computer).

## Troubleshooting DirectConnection

**PROBLEM:** $ECH_2O$ Utility tells me it can't connect to my device.

**SOLUTION:** Try one or more of the following to make sure there is a connection to the $ECH_2O$ device:

If you are using the accompanying USB cable, download the USB driver from www.decagon.com/support/downloads. Check your serial port choice. Make sure the "Connect Via" drop-down menu shows the name of the serial port you are using to physically connect to your logger or DataStation. For example, if our logger is physically connected to COM1, the "Connect Via" control should be set to "Direct on COM1 Communication Port".

Check that your serial cable is securely plugged into your logger or DataStation and your Computer.

Make sure your logger has good batteries or your DataStation is plugged in. Try pressing the reset button on your logger or DataStation.

**NOTE:** *Serial Cables can fail. If you suspect your serial cable may be the problem, try connecting to a second logger. If you can connect, the problem is probably the first logger. If you can't connect to the second logger either, the problem may be your cable. Try using a spare Decagon Serial Cable Adapter or the USB cable if you are having trouble connecting to a logger.*

**PROBLEM**: $ECH_2O$ Utility keeps reporting it lost the connection to my device.

**SOLUTION:** This rarely happens for a direct connection. Please check or replace your serial cables. You can also increase the number of times $ECH_2O$ Utility tries sending commands to the logger or DataStation. Increase the Direct Connect Retries on the Communication tab of the Preferences form.

## Troubleshooting Radio Connections

**PROBLEM:** $ECH_2O$ Utility tells me my radio modem isn't responding.

**SOLUTION:** Make sure your serial cable is securely attached to your computer and your Rm1. Your Rm1 should have power and be turned on.

**PROBLEM:** $ECH_2O$ Utility tells me it can't connect to my radio logger when I'm using an Rm1.

**SOLUTION:** Try one or more of the following to make sure there is a good radio connection to your remote logger:

- Make sure your DataStation and Em50R have the same Channel and Subchannel and that the DataStation is being continuously powered.
- Make sure you are within radio range of the remote logger by performing a telemetry test. If this is the problem, increase the radio signal strength to your logger by moving closer to your logger or using a high-gain antenna to see if you can establish a radio connection.

- Make sure the antenna on the logger and the Rm1 are securely fastened to the radio module.
- Check the Radio Channel and the Radio Sub Channel settings you are using on your remote loggers and Rm1. See Chapter 7, Connecting via a Radio Modem, for how to configure your radio settings.
- Make sure you wait ten minutes between connection attempts for the same logger. If you just disconnected from a logger, you must wait for ten minutes before that logger will accept radio connections (you can always direct connect to your logger).
- Make sure your logger has good batteries. Try pressing the reset button on your logger.

**PROBLEM:** $ECH_2O$ Utility keeps reporting it lost the connection to my device.

**SOLUTION:** This can happen when the radio connection is lost. Try increasing the radio signal strength by moving closer to the remote logger or using a high-gain antenna. You can also increase the number of times $ECH_2O$ Utility tries sending commands to the logger. Increase the Radio Connect Retries in the Communications tab on the Preferences form.

## Troubleshooting Data Issues

**PROBLEM:** $ECH_2O$ Utility tells me there is no new data for downloading.

**SOLUTION:** Make sure the logger is configured to measure data. Make sure the measurement interval is set to a number

greater than zero. Try pressing the reset button if the logger does have a non-zero measurement interval.

**PROBLEM:** My sensor data shows "* * *" in the Scan window.

**SOLUTION:** The three asterisks mean the raw data measured by the logger is out of expected range for the sensor. This could be caused by a broken sensor. Make sure the sensor is fully inserted into the logger's sensor port. Make sure the sensor type shown in the Scan window matches the sensor actually connected to your logger.

**PROBLEM:** My sensor data doesn't seem to be correct.

**SOLUTION:** There are many issues that affect the quality of the sensor measurement. Please see the user manual of your particular sensor for help troubleshooting the data collected by your sensor or contact Decagon by phone at 1-800-755-2751 or by email at support@Decagon.com.

## Troubleshooting Logger Issues

**PROBLEM:** My logger stopped making measurements.

**SOLUTION:** Make sure the measurement interval is not set to 0. The Em50 does not make any measurements when the measurement interval is set to zero.

Try pushing the reset button. Try initializing your Em50 if a reset isn't enough to get the logger measuring sensors again. Connect to the logger and choose "Initialize Device..." from the Device Tools sub-menu in the Actions menu. Initializing

your Em50 will erase any stored data so you should download any data you want to keep before choosing this option.

**PROBLEM**: My logger doesn't seem to be working correctly or reliably.

**SOLUTION**: Try pressing the reset button on the logger. This resets the logger's firmware. You can also try connecting to the logger and testing the integrity of the firmware. Choose "Test Device Firmware" from the Device Tools menu of the Actions menu. Contact Decagon for help reloading the firmware if $ECH_2O$ Utility reports the device firmware is corrupt. If the firmware tests good and your logger is still not working correctly, please contact Decagon for repair or replacement.

# Appendix A:

## Em50 CE Compliance

| | |
|---|---|
| **Application of Council Directive:** | 89/336/EEC |
| **Standards to Which Conformity is Declared:** | EN61326 : 1998<br>EN55022 : 1998 |
| **Manufacturer's Name:** | Decagon Devices, Inc.<br>2365 NE Hopins Ct.<br>Pullman,WA99163 |
| **Type of Equipment:** | Data collection sysem |
| **Model Number:** | Em50 |
| **Year of First Manufacture:** | 2002 |

This is to certify that the Em50, manufactured by Decagon Devices, Inc., a corporation based in Pullman, Washington, USA meets or exceeds the standards for CE compliance as per the Council Directives noted above. All instruments are built at the factory at Decagon and pertinent testing documentation is freely available for verification.

# Em50R/DataStation/Rm1 CE Compliance

**Application of Council Directive:** 89/336/EEC

| | |
|---|---|
| **Standards to Which Conformity is Declared:** | EN61326 : 1998<br>EN55022 : 1998 |
| **Manufacturer's Name:** | Decagon Devices, Inc.<br>2365 NE Hopkins Ct.<br>Pullman, WA 99163 |
| **Type of Equipment:** | Data collection system |
| **Model Number:** | Em50R 2.4 GHz<br>Rm1 2.4 GHz,<br>DataStation 2.4 GHz |
| **Year of First Manufacture:** | 2002 |

**Restrictions:**
*France*: Current regulations in France stipulate that these devices may be used indoors only. Outdoor use on private property is subject to authorization from the French Telecommunications Regulatory Authority. Outdoor use on public property is currently prohibited. For more information, see www.ero.dk.

# FCC Compliance

The following FCC statement applies to the Em50, Em50R, Em50G, DataStation, and Rm1.
This device complies with part 15 of the FCC Rules. Operation is subject to the following conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

The Em50R, DataStation, and Rm1 contain one of the following modules:

FCC ID: OUR9XSTREAM IC: 4214A-9XSTREAM
FCC ID: OUR-24XSTREAM IC: 4214A 12008

The Em50G contains the following module:

FCC ID: IHDT56HQ1 IC: 109O-HQ1

Information for users
Changes or modifications to the EM50 series loggers not expressly approved by Decagon Devices, Inc. could void FCC compliance and thus the user's authority to operate the equipment.

**NOTE*:*** This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate

radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct th***e*** interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult Decagon Devices or your local representative for support.

# Em50G CE Compliance

| | |
|---|---|
| **Application of Council Directive:** | 89/336/EEC<br>1999/5/EC |
| **Standards to Which Conformity is Declared:** | EN61326 : 1998<br>EN55022 : 1998 |
| **Manufacturer's Name:** | Decagon Devices, Inc.<br>2365 NE Hopkin<br>Pullman, WA 99163 |
| **Type of Equipment:** | Data collection sysem |
| **Model Number:** | Em50G |
| **Year of First Manufacture:** | 2010 |

**Cellular Module Information**

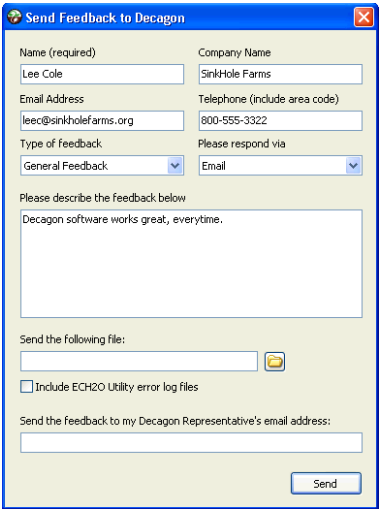
The Quad-band GSM/GPRS cellular module in the Em50G has been tested and approved under the standards and regulations listed below:

FCC part 12,22,24. FCC ID: IHDT56HQ1
Industry Canada (IC) 109O-HQ1
R&TTE - LVD 2006/95/EC
Standards: EN301 489-1 & 7, EN60950
EU Product Approval Number: G24-L
GCF 3.27.1
NAPRD 3.14.0
PTCRB

# Appendix B:

## Send Feedback to Decagon

Decagon Software makes it easy to send feedback, bug reports, and feature requests to Decagon or your Decagon Distributor. Choose "Send Feedback to Decagon..." from the help menu. This opens the window shown below.




Enter your name, company name, and other contact information. Tell us what type of feedback you are sending (General Feedback, Feature Suggestions, Bug Report, or Other). Indicate how you want us to respond to your feedback (Email or Telephone).

Use the description area to give details for your feedback. If you are reporting a bug, it is very helpful for you to tell us what steps you took for the bug to happen and any error message you saw. By default, bug reports also include the software error files.

You can send Decagon a file using this form too. This is useful for sending data files that you have questions about.

If you work directly with a Decagon representative, put their E-mail address in the field at the bottom of the form. This sends the contents of the form to them. Your Decagon representative can follow-up with you directly.

# Appendix C:

## Em50G User License Agreement

1. CONTRACT FORMATION

The use of the Em50G ("Device") is governed by the terms and conditions set forth herein. Please read these terms and conditions carefully. If you use or activate the equipment you agree to be bound by these terms and conditions. If you do not accept and agree to be legally bound by these terms and conditions, please do not use the equipment. If you choose not to accept these terms and conditions you may return the Em50G along with all original packaging and accessories for a refund of the purchase price less the cost of shipping and handling.

2. WIRELESS CONNECTIVITY

**Decagon** provides wireless connectivity for your EM50G for uploading of measurement data and logger status information- under a reseller licensing agreement. You will be charged a fee for wireless connectivity for your use of wireless services on your Device. Decagon reserves the right to discontinue wireless connectivity at any time or to otherwise change the terms for wireless connectivity at any time, including, but not limited to (a) limiting the frequency and amount of data that may be transferred using wireless connectivity and (b) changing the amount and terms applicable for wireless connectivity charges.

3. COVERAGE AND SERVICE INTERRUPTIONS

You acknowledge that if your Device is located in any area without applicable wireless connectivity, you may not be able to use some or all elements of the wireless services. Decagon is

not responsible for the unavailability of wireless service or any interruptions of wireless connectivity.

4. YOUR CONDUCT

You agree you will use the wireless connectivity provided by Decagon only in connection with services Decagon provides for the Em50G. You may not use the wireless connectivity for any other purpose. Unless specifically indicated otherwise, you may not sell, rent, lease, distribute, broadcast, sublicense or otherwise assign any rights to wireless services. You may use the Em50G Software only on the Em50G. You may not sell, rent, lease, lend, distribute or sublicense or otherwise assign any rights to the Software in whole or in part. You may not, and you will not encourage, assist or authorize any other person to, modify, reverse engineer, decompile or disassemble the Em50G or the Software, whether in whole or in part, create any derivative works from or of the Software, or bypass, modify, defeat or tamper with or circumvent any of the functions or protections of the Em50G or Software.

5. AUTOMATIC UPDATES

In order to keep your Software up-to-date, Decagon may automatically provide your Device with updates/upgrades to the Software.

6. EXPORT REGULATIONS

You agree to comply with all export and re-export restrictions and regulations of the Department of Commerce and other United States agencies and authorities, and not to transfer, or encourage, assist or authorize the transfer of the Software to a prohibited country or otherwise in violation of any such restrictions or regulations.

7. GOVERNMENT END USERS

The Software is a "Commercial item" as that term is defined at 48 C.F.R. §2.101, consisting of "Commercial Computer Software" and "Commercial Computer Software Documentation," as such terms are used in 48 C.F.R. §12.212 or 48 C.F.R. §227.7202, as applicable. Consistent with these provisions, the Software is being licensed to U.S. Government end users (a) only as a Commercial item and (b) with only those rights as are granted to all other end users pursuant to the terms and conditions of this Agreement.

8. NO ILLEGAL USE & RESERVATION OF RIGHTS

You may not use the Em50G, or the software for any illegal purpose. You acknowledge that the sale of the Em50G to you does not transfer to you title to or ownership of any intellectual property rights of Decagon or its suppliers. All of the Software is licensed, not sold, and such license is non-exclusive.

9. DATA STORAGE

The Em50G and Software will provide Decagon with data about your Device and its interaction with the software and information related to the content on your Em50G may be stored on servers in the United States at Decagon headquarters. You agree to assume sole responsibility to backup and store your data collected by the Em50G and Software.

10. Data Security and Privacy

While the Em50G and Software use cryptographic methods to protect the integrity of data transfers, Decagon does not guarantee privacy of measurement data or Device status information collected and transferred by the Em50G. You are solely responsible for the security of the Device access passwords issued to you by Decagon.

11. PATENTS

The Em50G and/or software used in association with the Em50G may be covered by one or more patents or pending patent applications, and/or copyright and trademarks or pending applications.

12. TERMINATION

Your rights under this Agreement will automatically terminate without notice from Decagon if you fail to comply with any term of this Agreement. In case of such termination, you must cease all use of the Software and Decagon may immediately revoke your access to the Service or to Digital Content without notice to you and without refund of any fees. Decagon's failure to insist upon or enforce your strict compliance with this Agreement will not constitute a waiver of any of its rights. You may terminate the service at any time, but you will be responsible for all payments under the data services through the end of the term.

13. DISCLAIMER OF WARRANTIES

**YOU EXPRESSLY ACKNOWLEDGE AND AGREE THAT USE OF THE EM50G, SOFTWARE AND DATA STORAGE IS AT YOUR SOLE RISK. *EXCEPT FOR THE ONE-YEAR LIMITED WARRANTY,* THE EM50G, SOFTWARE AND DATA STORAGE ARE PROVIDED "AS IS" WITH ALL FAULTS AND WITHOUT WARRANTY OF ANY KIND AND DECAGON AND ITS SUPPLIERS AND LICENSORS DISCLAIM ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, ACCURACY, QUIET ENJOYMENT AND NON-INFRINGEMENT OF THIRD-PARTY RIGHTS. NO ORAL OR WRITTEN INFORMATION OR ADVICE GIVEN BY DECAGON OR AN AUTHORIZED REPRESENTATIVE OF DECAGON SHALL CRE-**

**ATE A WARRANTY. THE LAWS OF CERTAIN JURISDICTIONS DO NOT ALLOW THE DISCLAIMER OF IMPLIED WARRANTIES.**

## 14. LIMITATION OF LIABILITY

**LIMITATION OF LIABILITY TO THE EXTENT NOT PROHIBITED BY LAW, NEITHER DECAGON NOR ITS SUPPLIERS OR LICENSORS SHALL BE LIABLE TO YOU FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES FOR BREACH OF ANY EXPRESS OR IMPLIED WARRANTY, BREACH OF CONTRACT, NEGLIGENCE, STRICT LIABILITY OR ANY OTHER LEGAL THEORY RELATED TO THE EM50G, SOFTWARE AND DATA STORAGE, INCLUDING, BUT NOT LIMITED TO, ANY DAMAGES ARISING OUT OF LOSS OF PROFITS, REVENUE, DATA OR USE OF THE EM50G OR SOFTWARE OR ANY ASSOCIATED PRODUCT, EVEN IF DECAGON HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. IN ANY CASE, DECAGON'S AGGREGATE LIABILITY UNDER THIS AGREEMENT SHALL BE LIMITED TO THE AMOUNT ACTUALLY PAID FOR THE DEVICE. THE LAWS OF CERTAIN JURISDICTIONS DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES.**

## 15. WASHINGTON LAW APPLIES

The laws of the state of Washington, without regard to principles of conflict of laws, will govern this Agreement and any dispute of any sort that might arise between you and Decagon.

## 16. DISPUTE RESOLUTION

By using the Em50G you agree to jurisdiction and venue of any dispute arising out of this agreement by the Whitman County Court unless the parties agree to a different dispute resolution process in writing.

17. SEVERABILITY

If any term or condition of this Agreement shall be deemed invalid, void, or for any reason unenforceable, that part shall be deemed severable and shall not affect the validity and enforceability of any remaining term or condition.

18. AMENDMENT

Decagon reserves the right to amend any of the terms of this Agreement at its sole discretion by sending an amended agreement in writing to you by first class mail or email. Your continued use of the Device and Software after the effective date of any such amendment shall be deemed your agreement to be bound by such amendment.

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